Queensland Murray Darling Basin Environmental Works and Measures Feasibility Program

Summary Report for Milestones 3 and 6 – Delivery of feasibility and pre-feasibility investigations.

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Contents

Summary

The Queensland Murray Darling Basin (QMDB) Environmental Works and Measures Feasibility Project aims to identify possible works and measures that may offset proposed reductions in diversion limits as identified in the Commonwealth Water Act 2007 - Basin Plan 2012 (the Basin Plan).
This overview report addresses Milestones 3 and 6 of the Project Agreement for the Environmental Works and Measures Feasibility Project. The linkages between the Project Agreement milestones and the Department of Natural Resources and Mines (DNRM) project plan milestones have been mapped and appear in Appendix 1.
Under Milestones 3 & 6, the Project Agreement identifies that Queensland is responsible for delivering;

a) Investigations/assessments - completed as per the project management plan
b) information - provided to assist determination of potential Sustainable Diversion Limits (SDL) offsets.

When commencing this program of work it was not immediately apparent to DNRM whether there were any significant proposals that would achieve SDL offsets in the QMDB area. Hence a two stage approach was developed.

Stage 1 was completed in two parts by consultant's RPS Aquaterra (in association with JTA Australia). In this stage, ideas for environmental works and measures in priority locations were identified (**Part A**), and investigation into possible recovery of overland flow (OLF) water licences in the lower Balonne was completed (**Part B**).
Stage 1 culminated in the compilation of potential projects into 4 recommended packages that would benefit from further assessment. Under the project agreement there were two levels of assessment. Feasibility assessment was undertaken for projects identified as having the greatest potential for achieving SDL offsets. Pre-feasibility assessment was undertaken for project ideas suggested by the community for which the possibility of SDL adjustments was unknown.

The packages recommended for feasibility assessments were;
Package 1 – Piping proposal for the Callandoon and Yambocully Water Supply Schemes.
Package 2 – Lower Balonne Works and Measures,

- strategic acquisition of Overland Flow Licences and the implementation of associated works and measures where relevant – Part B recommendations and
- Upgrade of outlet works on Bifurcation Weirs and Commonwealth use of off-stream storages in the Lower Balonne.

The packages recommended for pre-feasibility assessments were:
Package 3 – Fishways on structures including possible removal of some structures; in the Condamine, Balonne and Border Rivers catchments in conjunction with the strategic acquisition and management of regulated water entitlements.
Package 4 – Multi-Level offtakes from Glenlyon Dam to reduce thermal pollution.

The stage 1 outputs (see appendix 2 - Part A executive summary) delivered, in a preliminary sense, against parts a) and b) of milestones 3 & 6.

Stage 2 consisted of undertaking more detailed feasibility and pre-feasibility work. This stage was also completed in two parts with the feasibility assessments for **package 1 & 2** (which were aligned with Milestone 3) being completed by Alluvium Consulting Australia (Alluvium). The pre-feasibility assessments for **package 3 & 4** (aligned with Milestone 6) were completed by Department of Primary Industries (DPI) (NSW) and SunWater respectively.

The indicative costs and water savings for each of the priority project package options are summarised below.

	Scheme Cost	Water Savings	$/ML	Comments
Package 1 - Piping proposals (Border Rivers)				
Yambocully	$6990709	400ML	$17445	Water savings are equivalent to onfarm savings and not SDL offset. Economically unviable.
Callandoon	$6360549	1600ML	$3944	Water savings are equivalent to onfarm savings and not SDL offset. Potential for further consideration by the board under Healthy Headwaters Water Use Efficiency (HHWUE) program.
Package 2 – Bi-furcation weirs (Lower Balonne Works and Measures)				
Modification of Bifurcation weirs	$500,000	29,055ML	$17	Water savings indicated is the reduction in buyback volume to achieve the same target flow volume for the Narran Lakes, however, it does not account for reduction in flow to other streams. Hence the initial attractiveness presented here needs to be considered in a broader context.
Offstream storage				Preliminary investigations indicate potential to realise potential SDL offsets if operated in conjunction with bifurcation weir proposal. Opportunity to improve environmental benefits.
Package 3 - Fishways on structures (Border Rivers)				
Glenarbon	$800,000	0ML	NA	Installation of vertical slot fishway
Cunningham	$650,000	0ML	NA	Removal of structure
Bonshaw	$1,150,000	0ML	NA	Used Glenarbon as a surrogate for cost estimation.
Boggabilla	$1,000,000	0ML	NA	Upgrade to be considered in conjunction.
Package 4 - Multi-Level offtake for Glenlyon Dam (Border Rivers)				
Telescopic curtain	$4,000,000	0ML	NA	Based on Burrendong Dam NSW cost.
Bulkhead gates	$2,663,600	0ML	NA	Recommended option though not economically feasible.
Permanent valves	$3,600,000	0ML	NA	

Package 1: Assuming the option of full funding by the Commonwealth and full transfer of water savings to the Commonwealth, the findings reached were;

- the Yambocully scheme was not feasible under any circumstances (due primarily to economic considerations), and
- the option proposed for the Callandoon scheme is expensive, however the scale of the proposal could be altered should the Callandoon Water Board wish to consider other options to improve the economic feasibility.

Due to the water for these systems being measured at the offtake from the river, with losses attributed to the Water Allocation holders, there is limited potential for direct SDL offsets. There is however, the potential to save water through improvements to the supply works, hence improving the efficiency of water delivery. This is a similar vein to current HHWUE projects which result in water saved (or part thereof) being transferred to the Commonwealth.

Package 2: This proposal can be considered a constraint measure (where only work on the bifurcation weirs is considered). It is likely to be able to be considered a supply measure too, particularly if operated in accordance with a management framework and in conjunction with offstream storage. The potential for significant water savings (that may form a SDL offset) at a low cost provides a possible opportunity to reduce the water recovery burden in this key area. The department is keen to further explore the benefits of combining the bifurcation weir modifications with use of offstream storages to maximise the water delivery benefits while minimising the effects. The project plan for the remaining milestones 7 and 8 within the Program Agreement will focus on exploring this package further.

Package 3: This project is not economically feasible on the basis of high cost and no potential for SDL offsets. There is however potential for significant environmental benefits.

Package 4: This project is not economically feasible on the basis of high cost and no potential for SDL offsets. Additionally the current environmental effect/s are unknown.

Background

A Project Agreement for Queensland Murray-Darling Basin Environmental Works and Measures Feasibility Program between the State of Queensland and the Australian Government, was signed by the State Minister for Environment and Resource Management and the Australian Minister for Sustainability Environment Water Population and Communities (SEWPaC) in November 2011

The agreement is for Commonwealth funding contribution of $1.8 million to assist Queensland to:-

1. deliver feasibility investigations, including the costs, risks and benefits, of sustainable diversion limit (SDL) offset environmental works and measures project, and
2. deliver a State-led local process involving the development of local networks to enable engagement with local communities to assist the development of community based proposals for environmental works and measures and test the shortlisted community identified sub-projects through pre-feasibility assessment.

The project aimed to identify the prospects for environmental works and measures in priority locations for diversion limit reductions such as the Lower Balonne catchment of Queensland. Individual projects were identified and shortlisted for further development in close consultation with existing community groups and key stakeholders.

Feasibility assessments were then completed for the identified priority project packages. The assessments included development of preliminary cost estimates and economic viability. Assessments were also completed for the OLF options in the Lower Balonne.

This Report (for milestones 3 & 6) deals with the more detailed full feasibility and pre-feasibility investigations and assessments of the priority project packages that were determined through Stage 1 of the process, together with the outcomes of the investigations into Lower Balonne Overland Flow Licence acquisition and assessment of offstream storages. See appendix 1.

Outcomes and Outputs

DNRM is responsible for delivering feasibility investigations of potential SDL offset projects under the Project Agreement. This work forms the 3rd and 6th milestones to be delivered under the Project Agreement and has been carried out in two stages.

Stage 1

Stage 1 was completed in two parts by RPS Aquaterra (in association with JTA Australia). In this stage, the prospects for environmental works and measures in priority locations were identified (**Part A**), and investigation into possible recovery of overland flow (OLF) water licences in the lower Balonne was completed (**Part B**).

Part A

The **Part A** report (see appendix 2 – executive summary) identifies a number of ideas that have been shortlisted by a gateway process developed in consultation with the department and SEWPaC. A priority list of potential works and measures was developed. See table below from RPS Aquaterra report.

Table 3.1: Ranked Listing of EW&M proposals

Project No	Project Name	Project Code	Score
004	CEWH to own offstream storages	004 (4-CB-C)	35
006	Condamine Balonne: Fishways on structures (Warra Weir)	006 (3-CB-B)	32
007	Border: Fishways on structures (Cunningham, Bonshaw, Glenarbon)	007 (3-BR-B)	32
038	Upgrade of outlet works on Bifurcation regulators	038 (2-CB-B)	32
003	Storage and release of CEWH water using private diversion and storage works - Narran River	003 (1-CB-C)	31
039	Callandoon Creek and Yambocully Schemes - Pipe to water users	039 (1-BR-D)	31
041	Multi level offtakes from Glenlyon Dam	041 (3-BR-C)	30
045	Fishway on Chinchilla Weir	045 (3-CB-C)	30
019	Capture and later release of high flows downstream of St George	019 (2-CB-C)	29
034	Computer Aided River Management across Northern Basin	034 (1-BR-C)	28
005	Bullamon Plains wetland (Moonie River)	005 (4-M-B)	26
009	Condamine Balonne Gate Automation on Regulators	009 (2-CB-C)	26
002	Diversion Channel Culgoa Narran Rivers	002 (4-CB-C)	24
044	Sewage Treatment Plant Upgrade	044 (1-CB-C)	24
023	Alternative Supplemented Water Sharing Rules	023 (1-CB-A)	22
013	Pipeline to Narran Lakes	013 (2-CB-D)	21
010	Increase capacity of outlet works on Condamine Balonne SunWater Infrastructure	010 (1-CB-C)	20
029	Border Rivers mid-system re-regulating structures	029 (2-BR-C)	20
024	Improved Primary Supply Infrastructure in Lower Balonne	024 (1-CB-C)	19

Following a further review of the shortlisted proposals outlined above, and following the results of the **Part B** - Overland Flow Licence retirement investigations, the project team engaged with the DNRM Steering Committee to recommend the following proposals which would benefit from further full feasibility assessment or pre-feasibility investigations;
Recommended Feasibility Assessments
Package 1 – Piping proposal for the Callandoon and Yambocully Water Supply Schemes.
Package 2 – Lower Balonne Works and Measures, incorporating:

- Strategic acquisition of Overland Flow Licences and the implementation of associated works and measures – Part B recommendations;
- Upgrade of outlet works on Bifurcation Weirs; and
- Commonwealth use of off-stream storages in the Lower Balonne.

Recommended Pre-Feasibility Investigations
Package 3 – Fishways on structures (including the possible removal of some structures) in the Condamine, Balonne and Border Rivers Basin, in conjunction with the strategic acquisition and management of regulated water entitlements.
Package 4 – Multi-level Offtakes from Glenlyon Dam.

The recommended feasibility investigations (package 1 & 2 above) were aligned with progressing of milestone 3, while the recommended pre-feasibility assessments (package 3 & 4 above) were aligned with milestone 6.

Part B (Recovery of Overland Flow in the Lower Balonne)

The **Part B** report focussed specifically on identifying possible mechanisms and opportunities to allow for the recovery of overland flow (OLF) water in the Lower Balonne. The consultants engaged all water licence holders in the Lower Balonne in the development of the report and included specific property details including those owners potentially interested in participating in water recovery. Accordingly this report has not been released as a public document. A summary report of the outcomes of the Part B report has been produced to provide general information about the opportunities to recover water (appendix 3).

The summary report notes that the Commonwealth is only seeking to recover water from willing sellers and that there was considerable level of interest from the 14 water licence holders. Two distinct methods of controlling OLF diversions were identified to achieve a reduction in take;

- an audit process, where there is an ability to measure and audit diversions to ensure they remain consistent with the remaining take of water, and
- physical works, where a small number of identified storages would need physical decommissioning to return the flows to a more natural state.

The report provided an assessment of the total volume of water recovery that could be delivered through recovery of OLF licences and provided an indicative assessment of the costs involved, together with the potential costs for decommissioning. The report recommends that the process for moving forward with OLF recovery should establish a market value for OLF water, and present the best opportunity to deliver sustainable environmental outcomes.

Subsequent work by the Department furthered the thinking around using the existing 'willing seller' model to acquire OLF entitlements. This thinking has now matured with SEWPaC developing eligibility criteria for OLF and the latest tender process now calling for expressions of interest, (including OLF) that allow for purchase of OLF licences.
See http://www.environment.gov.au/water/programs/entitlement-purchasing/2012-13-lower-balonne.html

For further details on this assessment see the reports;

- *Queensland Murray Darling Basin Environmental Works and Measures feasibility project – Part B: Lower Balonne Overland Flow Licences retirement investigations* – RPS Aquaterra
- *Queensland Murray Darling Basin Environmental Works and Measures feasibility project – Part B: Summary Paper* – RPS Aquaterra
- *Recovering Overland Flow Water Licences in the Lower Balonne, Advancing another Bridging the Gap Opportunity* – DNRM

Stage 2

The department decided that the packages recommended in the Stage 1 report for both the feasibility investigations and pre-feasibility investigations would be put forward for further assessment to be completed as Stage 2.
Stage 2 was completed in two parts. The feasibility assessments for package 1 & 2 (which relate to milestone 3) were completed by Alluvium. The pre-feasibility assessments for package 3 & 4 (which relate to milestone 6) were completed separately.
The consultants (Alluvium) were tasked with developing feasibility assessments for the following packages identified in Stage 1;

- Water savings in the Yambocully and Callandoon Water Supply Schemes and a reduced scope of package 2
- Upgrade of Bifurcation Weirs in the Lower Balonne. Additional assessment work on utilisation of offstream storages in the Lower Balonne was included in the Invitation to Offer.

Several options for the above projects were put forward by Alluvium to the Steering Committee for the two packages in a draft options report. These options were further refined by the Steering Committee and the Yambocully and Callandoon Water Supply Scheme assessments were progressed on the basis that a channel delivery system would be significantly more cost effective than piping. Due to the water for these systems being measured at the offtake from the river with losses attributed to the Water Allocation holders,

there is no potential for an SDL offset. There is however, the potential to save water through improvements to the supply works. This would result in water saved being transferred to the Commonwealth, similar in style to current HHWUE projects.

The feasibility assessments include sufficient information including costs, potential water savings (for determination of potential SDL offsets where applicable), and possible ecological benefits of the projects to fulfil the requirements of milestone 3 of the program agreement.

Yambocully Water Supply Scheme

An investigation into the feasibility of a number of options to convey both supplemented and unsupplemented water to users in this scheme was completed. This resulted in a feasibility assessment being completed for a channel system.

The report (see Alluvium summary - appendix 4) covers the design of a channel system on an alignment utilising the existing pumping station and extension of the current channel. Investigation of Board operations enabled an assessment of potential water savings to be completed and an economic analysis was also completed. Environmental consideration indicates that there would be relatively little effect, with the proposal moving the system closer to a natural (pre-development) flow regime. The proposed channel alignment would also require a number of approval processes to be completed.

The results of the cost benefit analysis indicate that the Yambocully Water Supply Scheme proposal represents an extremely high cost of securing water for the environment. With potential water savings being a relatively small volume weighted against the significant cost of constructing the works, the proposal is not feasible and is not recommended to proceed beyond the level of assessment already completed.
For further details on this assessment see the report; *Assessment of water saving options for the Lower Balonne catchment and Yambocully/Callandoon water supply schemes* by Alluvium, April 2013.

Callandoon Water Supply Scheme

An investigation into the feasibility of a number of options to convey both supplemented and unsupplemented water to users in this scheme was completed. This resulted in a feasibility assessment being completed for a channel system.
The report covers the selection of a suitable alignment and design of a channel and pumping station. Investigation of Board operations enabled an assessment of potential water savings to be completed and an economic analysis was also completed. Environmental consideration indicates that there is relatively little effect, with the proposal moving the system closer to a natural (pre-development) flow regime.

While the boards practice of ‘piggybacking’ supplemented water on unsupplemented flows (to minimise losses) means that significant water savings are not available, it also reduces the environmental effect as the unsupplemented flows would still pass through the system.
The results of the cost benefit analysis indicate that the Callandoon Water Supply Scheme proposal represents a marginally feasible cost of securing water for the environment. While the project is not feasible from a SDL offset point of view, it is noted that the proposal significantly improves the Boards’ Water Allocation holder’s access to supplemented water. It identifies that further work by the Board on this option (or variation) may improve the attractiveness of the project as a water recovery measure.

For further details on this assessment see the report; *Assessment of water saving options for the Lower Balonne catchment and Yambocully/Callandoon water supply schemes* by Alluvium, April 2013.

Bifurcation Weirs and Offstream Storage in the Lower Balonne

The assessment of **package 2** (Lower Balonne bifurcation weirs plus use of off stream storages (see appendix 4 - Alluvium report summary) had two aims:

- to investigate the feasibility of improved regulation of bifurcation weirs in the Lower Balonne to direct low flows.
- to investigate utilising offstream storage in the Lower Balonne area for storage and later release of environmental water purchased by the Commonwealth to improve environmental outcomes – primarily for Narran Lakes.

The report covers possible engineering solutions to regulate existing low flows at the 1st and 2nd bifurcations, to enable better control to preferentially deliver water to the Narran River (and terminal lakes). The report also concludes that there is little benefit in regulating the 3rd and 4th bifurcation structures. The feasibility assessment was therefore progressed on the basis of modifications to two bifurcation structures only. The work completed indicates that this option has a very high likelihood of improving the management of environmental water flows in the Lower Balonne area, in particular, acting to improve the flow to the Narran Lakes during low flows.

The following extract from the summary to the Alluvium report details the investigation of the use of off stream storages.

The Narran River water harvesting entitlements purchased by the Commonwealth could be used to fill existing offstream storages. Towards the end of an event, the harvested water could be released back into the river to ensure efficient delivery to the Narran Lakes to assist meeting ecological requirements.

The initial understanding of the system is that there are already storage systems with spare capacity because of the current buy back of water and that there are a number of additional landholders who would be willing to sell water and make their storages available. Ideally the storages would be below Bifurcation Weir 2 on the Balonne Minor system and upstream of the refuge assets on the Culgoa system. An initial discussion with landholders as part of the consultation process indicated there is likely to be around 56GL of capacity on the Narran River (downstream of Weir 2) and 90GL on the Bokhara and Culgoa system. These storages are largely gravity fed and discharged so there would be few ongoing pumping costs.

It is proposed that the use of offstream storages could have a dramatic impact on the efficiency of water delivered to the Narran Lakes. If the Commonwealth operated an offstream storage facility on the Narran River that it filled using a portion of its purchased water entitlements, then it could have stored water available to release into the Narran River at the critical times.

A second option was considered where instead of a permanent change to the weirs directing water preferentially to the Narran River, the weirs are adjusted according to seasonal conditions and antecedent flows to direct water to where it is most needed on an event by event basis. This aligns with the philosophy of providing water to ecological assets in accordance with the Annual Environmental Watering Priorities developed by Queensland under the Basin Plan environmental management framework.

While the option of a permanent change to the operation of the weirs could be modelled using DNRM's Integrated Quantity and Quality Model (IQQM) this was not possible for temporary changes. Improvements to the IQQM would be needed to assess the impacts of ongoing active management of the upgraded weirs.

The conclusion of the Alluvium report is:

We therefore propose that whilst the bifurcation weir modification option essentially takes water from one system to deliver more to another, there is still the potential for water savings. Proceeding with a combination of modification to the weirs and offstream storage use could substantially increase the efficiency of delivering the water currently owned by the Commonwealth to key ecological assets. The extent of the water savings is not able to be specified at this stage and requires further investigation.

The modelled outcomes are useful to understand the extent of the benefit that could be provided to the Narran Lakes if a permanent change to the operation of the weirs was made, but it does not adequately reflect the proposed operation where the gates would be continually adjusted based on previous and anticipated flow events, and only for limited lengths of time

It is proposed that this combination approach is potentially a smart and efficient way to manage the Lower Balonne system and will more efficiently deliver the environmental water already purchased.

For further details on this assessment see the report; *Assessment of water saving options for the Lower Balonne catchment and Yambocully/Callandoon water supply schemes* by Alluvium, May 2013.
See also http://www.environment.gov.au/ewater/publications/private-storages-report.html

Fishways on Structures

The Department has utilised a body of work completed (previously) by NSW DPI. See appendix 5 – DPI fishway report executive summary. This work identified 12 priority weirs of which half were in the QMDB area. Three of these were located in the Border Rivers basin area identified in package 3 and, along with consideration of upgrading of existing structures, are tabled below.

Weir	Stream	Fishway Type	SDL Offset	Cost
Glenarbon	Dumaresq	Vertical slot	0ML	$800,000
Cunningham	Dumaresq	Removal of structure	0ML	$650,000
Bonshaw	Dumaresq	Vertical slot	0ML	$1,150,000
Boggabilla	Macintyre	Upgrade of existing Vertical slot	0ML	$1,000,000

Essentially these are significant costs and there is no potential for SDL offsets. Consideration of this work fails to meet the Commonwealth's definition of supply, constraint or efficiency measures in the Commonwealth Water Act 2007 – Basin Plan 2012. Despite this, consideration of fish ecology and migration indicates there is opportunity for significant environmental benefit, through improvement of fish passage conditions.
For further details on this assessment see the report; *Fishway options for weirs of the Northern Murray – Darling Basin* by DPI (NSW).

Multi-level offtake on Glenlyon Dam

Pre-feasibility assessment of **package 4**, proposed modification of the existing single low level offtake tower at Glenlyon Dam into a multi-level offtake, was carried out by SunWater. Three options for modification were weighed up; telescopic curtain, bulkhead gates, and permanent valves. Consideration of the operation and design of the existing tower, ease of operation and cost formed the primary criteria. Evaluation of these options led to the recommendation of the removable bulkhead option, in particular the option of utilising new 4.0m combination trash screen and bulkhead gate. See appendix 6 - SunWater report executive summary.

Option	Water Savings	Scheme Cost
Telescopic curtain	0ML	$4,000,000
Bulkhead gates (4m gate option)	0ML	$2,663,600
Permanent valves	0ML	$3,600,000

Preliminary consideration of the design of this option resulted in two alternatives being considered. These were for construction of 1.83m bulkhead gates to fit in with existing trash screens and construction of new combination trash screen/bulkhead gates at 4.0m that could replace the existing screens. Weight considerations would require the 4m gates to be constructed of aluminium.

The bulkhead gates option is simple and proven, makes best use of the existing asset, minimises initial cost and allows for future modifications. Bulkhead gates have been used successfully on other SunWater dams to manipulate the level of draw and the design of the gates draws on the design of the Boondooma Dam gates.

To fully assess the benefits of the proposal further work is required to determine the environmental effects of the current release operations, particularly the extent and impact of any cold water (thermal) pollution, Despite the potential for environmental benefit, the proposal does not provide any opportunity for a SDL offset and is not aligned with supply, efficiency or constraint measures.
For further details on this assessment see the report; Glenlyon Dam – pre-feasibility study into modification of offtake tower into a multi-level offtake by SunWater, April 2013.

Milestone Completion

The Stage 1 and Stage 2 consultancies have provided a number of reports that detail the project journey from stakeholder engagement and identification of potential projects through to feasibility and pre-feasibility investigations/assessments of the priority projects. The reports completed for the four prioritised projects (packages) include work on costs and benefits, potential water savings for SDL offsets (where applicable) and sufficient infrastructure detail that can be used to enable a decision to be made on whether either or part of the projects should progress further to the design, financing and construction phases.

Further Work and Actions

DNRM supports a number of recommendations that were made through the work comprising this milestone. Many of these involve improved modelling to allow the increasingly complex water delivery and management scenarios to be readily tested. DNRM is keen to discuss proposed improvement to existing or new models with the Commonwealth and to use these

to further progress assessment of the Lower Balonne bifurcation weirs/use of off stream storages proposal.

As stated in the Alluvium report: *there is scope to develop an operational plan of manipulating the weir flows to provide both a better ecological outcome for the Narran Lakes and no detrimental impacts to any other part of the system. The ecological assessment needs to be much more detailed to integrate with the modelling. In particular the refuge areas of the Culgoa need to be better understood in the context of fewer low flows. The current Northern Basin Workplan being implemented by the MDBA will be reviewing the science on which the Ecological Sustainable Level of Take for the Basin Plan was based. This should include an assessment of whether the existing ecological targets and flow indicators are suitable. Any findings can be incorporated into future ecological assessments*.

With the Commonwealth water recovery group having implemented processes to enable the recovery of overland flow water licences in the Lower Balonne, the department is committed to continuing to work with the Commonwealth on developing and implementing processes to maximise the environmental benefits of this water. The work to date on offstream storages will inform this discussion. Again this discussion can be advanced by improvement to the existing models.

The recommended work or actions that have been raised in the feasibility and pre-feasibility assessments have been ranked based on consideration of the importance to the furthering of the Commonwealths water recovery program.

	Work / Action	**Ranking**
Lower Balonne catchment		
1	Model development / improvement to allow more complex proposals for water delivery and water management options to be tested.	High
2	Engage stakeholders re – bifurcation weir options including operation and management protocols and opportunities to integrate use of existing or new offstream storage.	High
3	Work to increase the knowledge and understanding of the environmental water requirements of Lower Balonne assets (other than Narran Lakes and the Culgoa floodplain).	High
4	Continued support of OLF licence buyback activities	Medium
Border Rivers catchment		
5	Engage Callandoon Water Board with a view to handing the proposal over to them for further work on alternative options for consideration under the HHWUE program. May require changes to current HHWUE eligibility criteria.	Medium
6	Develop methodology to determine the value of improved fish passage against water recovery program.	Low
7	Specific studies to improve understanding of thermal pollution caused by operation of Glenlyon Dam	Low

After the completion of this phase (Milestone 3 & 6) of the project, two milestones remain. These milestones support continued engagement on environmental works and measures across the basin over the following two years. The department has commenced drafting a project plan to map activities over these two years, and, based on the outcomes of milestone 3 & 6, the primary focus will be on the Lower Balonne bifurcation weirs and use of off stream storages proposal.

Appendices

- Appendix 1 – Milestone linkages
- Appendix 2 – Stage 1 Part A report - executive summary – RPS Aquaterra report
- Appendix 3 – Stage 1 Part B summary paper – RPS Aquaterra
- Appendix 4 – Stage 2 summary – Assessment of water saving options for the Lower Balonne catchment and Yambocully/Callandoon water supply schemes - Alluvium
- Appendix 5 – Stage 2 Fishway options report – executive summary - DPI
- Appendix 6 – Stage 2 Multi-level offtake report – executive summary – SunWater

Appendix 1 – Milestone Linkages

Project Agreement Milestone	Date (SEWPaC)	Milestone Status (SEWPaC)	Project Plan Milestone (DNRM Plan)	Milestone Status (DNRM)	Deliverables (Commonwealth)	Reports / Products	Comments
Milestone 1 - Acceptance of project management plans for the State project	31 August 2011	Completed	2. Finalise project management plan for the works and measures program and submit to Commonwealth for approval	Completed	Finalised project management plan. Project Management Plan Version 1.7 November 2011.	Nil	
Milestone 2 - Engagement of project team and procurement of staff/consultant to deliver the project	31 October 2011	Completed	1. Form Project Steering Committee	Completed	DNRM project Steering Committee formed. First meeting held August 2011.	Nil	
			3. Engagement of Associate project manager and procurement of consultant to deliver the project	Completed	Project manager appointed for the Eworks project. Consultancy awarded to RPS Aquaterra (Stage 1). Signed contract and governance structure of DNRM staff.	Nil	Sent to SEWPaC - Copy of executed contract between DERM and RPS Aquaterra, Project Plan for State led process, specific project team, invoice for payment of Milestones 2 and 4
Milestone 3 - Completion of State project a) Investigations completed as per the project management plan b) Information provided to assist determination of potential SDL offsets c) Acceptance of final report	31/12/2012 REVISED DATE 1 May 2013	Submitted	4. Development of an implementation program to identify an appropriate mechanism, constraints and risks for the recovery of overland flow in the Lower Balonne	Completed	Report to the Commonwealth outling the suite of options for dealing with recovery of OLF in the Lower Balonne.	Part B report - *RPS Aquaterra (not published)* Part B Summary report - *Aquaterra* (this report available for the web) Recovering Overland Flow in the LB - advancing a bridging the gap opportunity -*DNRM*	Part B report and summary report given to SEWPaC early 2013
			5. Preliminary short-list and reports of categorized QMDB sub-projects from community and stakeholder engagement that have potential to create SDL offsets	Completed	Short-list of potential projects developed with stakeholder input. As per 1.6 of the project plan the shortlist will include a. prioritsed sub-projects, b. pre-feasibility cost estimates of each priority sub-project, c. Potential SDL offsets - hyrological assessment.	Part A report - *RPS Aquaterra*	Part A report sent to Vince Keogh at SEWPaC on 16th Nov 2012
			8. Technical assessments of short-listed sub projects, costs and benefits and hydrological assessments	Completed	Feasibility assessments of prioritised projects, (Yambocully, Callandoon, Lower Balonne bifurcation weirs) including OLF in Lower Balonne	Feasibility report - Assessment of water saving options for the Lower Balonne catchment and Yambocully/Callandoon water supply schemes - *Alluvium*.	Draft Report sent to Vince Keogh at SEWPaC on 3rd May for comment
			9. Delivery of final-shortlisted sub-projects of works and measures to Commonwealth for determination of potential SDL offsets	Completed	Final Milestone 3 report sent to the Commonwealth with final feasibility assessment completed	Interim Summary Report -*DNRM* Milestone 3 report -*DNRM*	Report submitted
Milestone 4 - Acceptance of project management plan for the State - led community engagement process	31 October 2011	Completed		Completed	Plan for the State led community engagement process from the start of the Eworks project.	DNRM Project Management Plan with Community strategy.	Sent to SEWPaC - Copy of executed contract between DERM and RPS Aquaterra, Project Plan for State led process, project team, and invoice for payment of Milestones 2 and 4
Milestone 5 - Completion of the identification and prioritisation of community ideas and short-listing of the community identified sub-projects for pre-feasibility assessment, in accordance with the project management plan for the State-led community engagement process as agreed by the Parties	30/07/2012 REVISED DATE 30 November 2012	Completed	6. Submit preliminary, prioritised list of stakeholder and DERM identified sub-projects to Commonwealth for pre-feasibility Assessment	Completed	Prioritised list from the consultants (RPS Aquaterra Stage 1) of sub-projects for pre-feasibility assessments (Glenlyon Dam and Lower Balonne fishways)	Part A report - *RPS Aquaterra* Feasibility report - Assessment of water saving options for the Lower Balonne catchment and Yambocully/Callandoon water supply schemes - *Alluvium*.	Part A report emailed to Vince Keogh 16th Nov 2012.Work underway by Sunwater and proposal to use existing fishway work.
Milestone 6 - Completion of pre-feasibility assessments for Sub-projects shortlisted through the community engagement process including their potential for SDL offsets; and acceptance of final report.	31/01/2013 REVISED DATE 1 May 2013	Submitted	7. Outcome report on investigations on barriers to fish passage in the Lower Balonne system	Completed	Pre-feasibility assessments for both Glenlyon Dam offtake and Lower Balonne fishways	Glenlyon Dam - Pre-feasibility study into modification of offtake tower into a multi-level offtake - *SunWater* Fishway options for weirs of the Northern Murray-Darling Basin -*DPI*. Milestone 6 report -*DNRM*	Reports submitted with Milestone 6 report.
Milestone 7 - Acceptance of project management plan for FY 2013/2014 to support continued engagement on environemental works and measures projects across QLD Basin districts	TBC 30/07/2013	Commenced	no milestone in current project plan	Commenced	A finalised project plan for the 13/14 financial year for the continuation of engagement on Eworks projects		Project plan to be developed and agreement from all parties.
Milestone 8 - Acceptance of project management plan for FY 2014/2015 to support continued engagement on environmental works and measures projects across the QLD Basin districts	TBC 30/07/2014	Yet to start	no milestone in current project plan	Yet to start	A finalised project plan for the 13/14 financial year for the continuation of engagement on Eworks projects		Project plan to be developed and agreement from all parties.

Appendix 2 – Part A executive summary – RPS Aquaterra

EXECUTIVE SUMMARY

The Department of Environment and Resource Management (now Department of Natural Resources and Mines DNRM) commissioned RPS Aquaterra (in association with JTA Australia) to provide consultancy services for the Queensland Murray-Darling Basin Environmental Works and Measures Feasibility Program.

The objectives of the QMDB environmental works and measures feasibility project are as follows:

Part A - To develop a prospectus of potential environmental works and measures (EW&M) with priority opportunities identified that would propose on ground works or other measures that:

- Overcome constraints to achieving environmental outcomes at assets of high conservation value and/or
- Reduce the impact of the transition to new Sustainable Diversion Limits (SDLs) that will be set under the Basin Plan

Part B - To develop an implementation program that will identify an appropriate mechanism, constraints and possible works (e.g. decommissioning) to allow for the recovery of existing overland flow water licences (OFL) in the Lower Balonne area.

The project is designed to lessen the burden of mandatory Sustainable Diversion Limits in priority locations where diversion limit reductions are proposed under the Murray- Darling Basin Plan, these are explained further in Section 5 of this report.

This report describes the outcomes of the first stage (Part A) of the Queensland Murray-Darling Basin (QMDB) Environmental Works and Measures Feasibility Program, which was to develop a comprehensive list of possible environmental works and measures primarily derived from a prescribed stakeholder engagement process. This was followed by a more detailed evaluation of the proposals against predetermined criteria in order to shortlist those proposals. The second stage will be to carry out feasibility studies of the shortlisted proposals.

Separate tasks associated with the delivery of the second project objective (Part B above), dealing with the direct engagement with Lower Balonne Overland Flow Licence holders, is described in a separate report.

The Queensland river basins which are considered in this project are the Condamine and Balonne, Moonie and the Queensland Border Rivers, comprising the Barwon, Macintyre, Dumaresq and Severn Rivers. The total catchment area of these river basins is approximately 163,000 km2, 15% of the total area of the Murray-Darling Basin. The amount of surface water currently authorised to be used in these basins represents about 10% of the total amount authorised in the whole Murray-Darling Basin. These river basins are ones in which reductions in the sustainable diversion limits are proposed as part of the Basin Plan.

Initial contact with stakeholders was arranged by JTA Australia. The stakeholders in this project included representatives of local Councils, members of natural resource management and environmental groups, water user groups, and peak industry bodies. A number of EW&M proposals were received through this initial contact.

In order to evaluate the proposals, and obtain a shortlist of proposals for further more detailed investigation, a short listing methodology was required. The method of assessment and short listing of proposals was achieved through a technical workshop held on 15th May 2012. Representatives from DRNM, and RPS and JTA attended the meeting. Representatives from the Commonwealth departments SEWPaC and MDBA also attended, but in an observer capacity, and to provide some responses to questions on Federal Government policy.

Through the workshop, a two stage process for proposal evaluation was developed:

1. An initial Gateway or filter, to determine whether the proposals were within the scope of the project; and
2. A simple evaluation matrix based on responses to questions concerning environmental benefit, community acceptance, "road readiness", implementation time, and regulatory changes.

Following the workshop, stakeholder meetings were held in Dalby, St George and Dirranbandi, to discuss the background of the project, and to elicit further EW&M proposals. These meetings were arranged by JTA and attended by stakeholders, DNRM representatives, and JTA and RPS personnel. Summaries of these meetings are contained within the report.

A total of approximately 50 proposals were compiled based on responses from stakeholders, including some initial proposals supplied by DNRM.

Evaluation of the proposals resulted in 19 proposals passing the initial gateway (being within the scope of the study). These 19 proposals were evaluated and ranked by a group using the simple selection matrix method. Details of the method and the scoring of the proposals are contained within this report.

The shortlisted proposals arising from this evaluation are described below.

Fish Passage

Three shortlisted proposals related to improvement of fish passage in the Condamine and Balonne and Border Rivers. There are numerous structures without fishways on these streams, and there have been a number of investigations aimed at defining and prioritizing construction of fishways on existing structures. Priority structures for construction of fishways are Warra Weir on the Condamine River, Cunningham Weir (removal), Bonshaw Weir and Glenarbon Weir on the Border River, and Chinchilla Weir on Condamine River.

Fishways on existing structures will allow enhanced environmental outcomes with the same amount of water.

Bifurcation Weir Outlets

One of the shortlisted proposals is the upgrade of outlet works on bifurcation flow regulating structures. There are eight regulating structures (sheet pile weirs with low flow slots) on the Lower Balonne distributary system downstream of St George. These structures split the low flows (environmental, stock and domestic) passing St George into pre-determined proportions down the distributary system including Culgoa, Balonne-Minor, Narran, Bokhara, Ballandool and Birrie streams.

Construction of variable outlets (in particular on the B2 regulators) will allow greater control over the distribution of flows for environmental benefit. For example, during those occasions when flows may need to be directed down the Narran River to Narran Lakes, to extend bird-breeding opportunities following a flow-through event, variable outlets on the regulating structures will facilitate this.

With controlled outlets, environmental outcomes can be achieved with less water.

Piping to Callandoon and Yambocully Schemes

The Border Rivers ROP provides for both the Yambocully and Callandoon water boards to be issued with distribution operations licences that authorise them to divert water from the Border Rivers trunk stream and distribute water to their customers.

Contractual arrangements allow the boards to levy rates and charges for their services, and to charge exit fees for any water that may be traded away from their supply area. The boards' financial interest in each water allocation is recorded on the Water Allocations Register. Separate contractual arrangements address the boards' relationship with the resource operations license holder.

Water (both supplemented supplies and unsupplemented water) is diverted from the Border River and along over 150 km of anabranch channel. Losses are high, and it is expected that 20% to 30% of the total 14,400 ML supplemented nominal allocation to the water users is lost in delivery from the Border River to the users' pumps.

If the supplemented supply were piped, the savings in the losses could be shared among the CEWH and the users. While there may be a number of issues with this proposal including capital and operating costs, quantification of the actual water savings through reduction in losses, and regulatory hurdles, the proposal would result in water savings and in benefits to the environment, through returning the anabranches to a more natural flow regime.

This proposal would results in water savings, while at the same time enhancing environmental outcomes.

Glenlyon Dam Multi-level Offtake

The level at which water is drawn from Glenlyon Dam for release downstream cannot be varied. Investigations have indicated that there could be cold water pollution impacts up to 30 kilometres downstream of the dam, along Pike Creek and the Dumaresq River, although no comprehensive monitoring or study of the impacts is known to have been undertaken.

Modification of the existing intake structure to allow selection of the levels from which water is drawn for releases will allow much better control over the water quality (including temperature) of releases, and provide better environmental outcomes with the same amount of water.

CEWH Use of Off stream Storages

This proposal applies to off stream storages downstream of St George including those near the Narran River and other distributaries.

Water harvesting into ring tanks beside the Narran River or Balonne River could occur, and this water could be released at the discretion of CEWH on the tail of small flow events to prolong flows into Narran Lakes Ramsar listed site on those occasions when bird breeding opportunities might need to be extended.

Packaged EW&M Measures

During the consultation process, a number of stakeholders suggested that a number of the proposals would have significantly greater beneficial impact within a coordinated a package of measures, than as stand-alone proposals. Many of the proposals will allow held environmental water entitlements to more efficiently or effectively deliver recovered water than would be possible otherwise.

It is suggested that the shortlist of EW&M proposals developed by through this project should be reviewed during the development of feasibility studies to identify potential synergies between the EW&M proposals, or in management and use of held environmental water entitlements in conjunction with the EW&M proposals.

While further feasibility studies will be required prior to any meaningful analysis, there are two obvious examples that highlight the type of additional benefits that could potentially be gained through a combination of EW&M works, with other environmental activities.

1. Fish passage and release of regulated water - The benefits of construction of fishways could be enhanced through the strategic acquisition of regulated water entitlements
2. Recovery, storage and release of environmental water in the Lower Balonne combined with structural works, mechanisation and possible automation of the bifurcation weirs. It is proposed that the feasibility study for construction of automated, variable outlets on the bifurcation weirs, and the study for the use of a store and release strategy in the Lower Balonne should be considered in combination, as well as under stand-alone conditions. This study should also consider the extent to which the environmental, stock and domestic passing flow rule, and the event management rule for low flows (under s38 of the Condamine and Balonne Water Resource Plan) could benefit from combination of these two environmental works and measures proposals.

Following a further review of the shortlisted proposals, as outlined above, and the results of the Part B- Overland Flow Licence retirement investigations the project team engaged with the DNRM Steering Committee to recommend the following proposals be carried forward to either full feasibility assessment or further pre-feasibility investigations;

Recommended Feasibility Assessments

Package 1 – Piping proposal for the Callandoon and Yambocully Water Supply Schemes.

Package 2 – Lower Balonne Works and Measures, incorporating:

- Strategic acquisition of Overland Flow Licences and the implementation of associated works and measures – Part B recommendations;
- Upgrade of outlet works on Bifurcation Weirs; and
- CEWH use of off-stream storages in the Lower Balonne.

Recommended Pre-Feasibility Investigations

Package 3 – Fishways on structures in the Condamine Balonne and Border Rivers Basins.

Package 4 – Multi-level Offtakes from Glenlyon Dam.

Appendix 3 – Part B summary – RPS Aquaterra

RPS Aquaterra

jta Australia Community CONSULTANTS

QUEENSLAND MURRAY DARLING BASIN
ENVIRONMENTAL WORKS AND MEASURES FEASIBILITY PROJECT
PART B – SUMMARY PAPER

LOWER BALONNE OVERLAND FLOW LICENCE RETIREMENT INVESTIGATIONS

The Department of Natural Resources and Mines (DNRM) commissioned RPS Aquaterra Consulting Pty Ltd in association with JTA Australia to provide consultancy services for the Queensland Murray Darling Basin Environmental Works and Measures Feasibility Program.

The QMDB environmental works and measures feasibility project had two distinct components:

- Part A: Develop a prospectus of potential environmental works and measures that overcome constraints to achieving environmental outcomes and/or reduce the impact of the new Sustainable Diversion Limits (SDLs) set under the Basin Plan. ***The Part A report is available through DNRM.***
- Part B: Identify appropriate mechanisms, constraints and possible works to allow for the water recovery of overland flow water licences in the Lower Balonne area. ***The Part B report includes information that is considered to be confidential and as such the report has not been made available for general public consumption. The following is a summary of the report and its broad findings.***

SCOPE OF PART B WORK

The Part B process was focussed on data collection and discussion with the 14 overland flow (OLF) licence holders in the Lower Balonne to identify possible water recovery options, such as inclusion of OLF licences in an open tender process, as well as decommissioning of works or active management of OLF water.

The approach taken to Part B centred on targeted consultation with each of the OLF licence holders to explore levels of interest in the sale, modification or retirement of part or all of their entitlements. Discussions about the willingness of individual licence holders to participate in the process, and about constraints to participation in the process were held confidentially, and the results of these discussions provided to DNRM and the Commonwealth Government Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) with the intention that it not be distributed publically.

Licensing details of the 14 water licence holders were provided to RPS and JTA at the beginning of the consultancy. **Table 1** provides some key information on these licences. **Figure 1** shows the areas on which the works to capture overland flow are located, the location of the storages and their total capacity and modelled long term average diversion (the basis for considering a tradable entitlement) for each of the 14 OLF licences.

The report provides a summary of the results of consultation activities to date and options for moving forward to achieve water recovery from voluntary participants, for consideration by DNRM and SEWPaC.

KEY FINDINGS

There are 14 water licences that were granted in accordance with the Condamine and Balonne Resource Operations Plan in the Lower Balonne area. The Commonwealth is seeking to only recover water from willing sellers; therefore engagement of the licence holders was essential although broader stakeholder engagement on this issue was also required.

It can be concluded from the consultation undertaken that there is a considerable level of interest from both the Commonwealth Government and a significant number of the 14 licence holders in partaking in a process to trade all, or part, of their Overland Flow Entitlements. The key points to note include:

- **Decommissioning versus measurement**

In reviewing the physical layout and operation of the overland flow (OLF) harvesting works in the Lower Balonne, it is apparent that there are two distinct methods of controlling OLF diversions to achieve a proven, demonstrable reduction in take, and consequent increase in natural flows. The diverse arrangement of OLF harvesting works will require case by case assessment, and the appropriate method of control may vary depending on whether the OLF take will cease entirely, or whether it will be reduced to some fraction of the current level of diversion. The two methods of implementing the changes are through:

- **Audit process:** This method requires only the ability to measure and audit diversions to ensure that these are consistent with the authorised remaining take of water. As with entitlements to access unsupplemented (unregulated) flows from the river or watercourse, the legal entitlement to take overland flow from the floodplain is specified through licence conditions. To achieve an appropriate level of accountability, all water entitlements on the property would need to be managed under the multi-year accounting rule (which is required under the existing trading rules set out in the Condamine and Balonne Resource Operations Plan).
- **Physical works:** a smaller number of diversion works on the floodplain will require physical decommissioning to return the flows to a more natural state. Even where there is no active use of the water (i.e. for irrigation), the physical structure will significantly alter natural flow patterns, either in terms of the location or the quantity.

The Part B report made an initial assessment of which works would require physical alteration in order to achieve a reduction in diversions from the floodplain. This information was made available to DNRM and SEWPaC so as to provide an understanding of the additional requirements that need to be considered when developing arrangements for any specific buy-back packages.

- **Method of achieving water recovery**

The report provided an assessment of the total volume of water recovery that could be delivered through recovery of OLF licences, and provided an indicative assessment of the costs involved in these purchases, and the potential scope for additional costs for decommissioning or other works (based on a proportion of the total cost). It should be noted that the adopted costs were based on known historic market value for entitlements (based on previous trades in Unsupplemented entitlements) and were intended only to give an indication of the magnitude of the total investment required should OFL acquisition be pursued as a mechanism to bridge the SDL gap.

Through discussions with OLF licence holders it was identified that there was a level of interest in participation in a 'willing sellers' water recovery program. With a significant recovery of water proposed for the Lower Balonne, options for combined works and measures to achieve effective and efficient delivery of this water should be considered. To date, water recovery in the Lower Balonne has focused on unregulated water harvesting entitlements. These entitlements, when held by the CEWH, could be returned to the environment by simply not diverting during high-flow events.

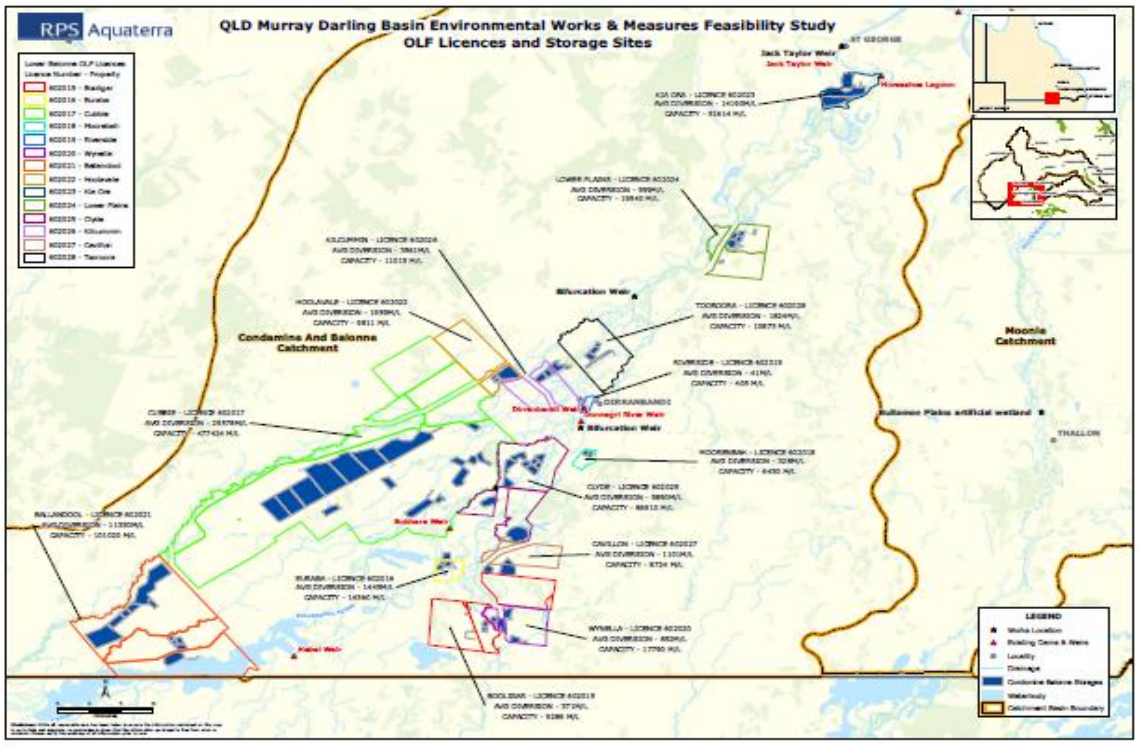
A combination of OLF acquisition, a store and release strategy, and automated variable outlets on the bifurcation weirs would allow the manipulation of environmental flows to achieve enhanced outcomes. These measures, in combination with an appropriate management plan would allow the targeted provision of flows to downstream environmental assets, in particular the Culgoa floodplain and the Narran Lakes.

The report recommends that the process for moving forward with OLF recovery should establish a market value for OLF water (in accordance with Government procurement guidelines), and present the best opportunity to deliver sustainable environmental outcomes through targeted acquisition. It is suggested that this could be achieved by running a two part expression of interest and tender process

for overland flow licences in conjunction with the development of a business case for associated environmental works and measures.

Table 1: Details of overland flow licences Lower Balonne area

Licence No	Property	Max Diversion Rate (ML/day)	Volumetric Limit (ML)	Mean Annual Diversion (Cap Model) (ML)	Comments
602019	Riverside	8.2	252	41	Two year accounting water sharing rule - max 252 ML
602022	Hoolavale	595	9,820	1,960	9,820 ML at any time
602025	Clyde	2,594	88,600	14,349	88,600 ML at any time; Surge Works 28,390 ML
602023	Kia Ora	7,410	116,100	14,208	116100 ML can be taken at any time
602017	Cubbie	8,330	469,500	29,620	468500 ML can be taken at any time
602015	Booligar	124	9,860	371	9,860 ML at any time
602021	Ballandool	11399	90,500	11,413	90,500 ML take at any time, Surge works 11,400 ML
602020	Wynella	360	15,000	853	15,000 ML at any time, Surge works 2,390 ML
602016	Euraba	323	14,300	1,445	14,300 ML at any time
602026	Kilcummin	114	8,360	3,560	8,360 ML at any time, Surge works volume 1,700 ML
602024	Lower Plains	751	19,400	1004	19,400 ML at any time
602028	Tooroora	352	12,082	1591	12,082 ML at any time
602018	Moorenbah	84	6,100	329	6,100 ML at any time
602027	Cavillon	108	6,830	1100	6,830 ML at any time



Appendix 4 - Summary Alluvium Report

Alluvium (2013) Assessment of water saving options for the Lower Balonne catchment and Yambocully/Callandoon water supply schemes. Final report by Alluvium Consulting Australia for DNRM, Toowoomba Qld

Under the Water for the Future initiative, the Australian Government has recently made available funds from the Sustainable Rural Water Use and Infrastructure Program for an Environmental Works and Measures Feasibility Program.

The Environmental Works and Measures Program aims to improve the health of our river systems by making the best use of water for the environment. Works and Measures programs fund infrastructure to deliver and manage water at icon and other important sites.

To date there have been limited opportunities in Queensland to undertake these kinds of activities largely due to the unregulated nature of Queensland Murray-Darling Basin rivers. This contrasts with the situation in the Southern Basin where rivers are heavily regulated by infrastructure.

This work follows a preceding project which sought to identify a large range of potential Works and Measures opportunities across the Murray Darling system in Queensland. The shortlisted options included proposals to improve fish passage, upgrade bifurcation flow regulating structures on the Lower Balonne system, pipe the Callandoon and Yambocully schemes, install a multi-level off-take on Glenlyon Dam and the use of offstream storages downstream of St George on the Narran River.

The report from that project identified the two highest priority options were to pipe the Callandoon and Yambocully Water Supply Schemes, and an upgrade of outlet works on Bifurcation Weirs in the Lower Balonne. Those two options are further progressed in this report.

Definition of water in the study area

It is valuable to understand the types of water within these systems in order to understand how they are represented in discussion within this document. The types of water used by landholders and the environment are presented below:

Table 1. Descriptions of the types of water referred to in this report.

Types of water	Description
Environment, Stock and Domestic water (ESD)	ESD is also referred to as 'compensation' flow and applies only in the Lower Balonne. This is provided under the operational rules of Beardmore Dam, by which the first 730 ML of daily flow into the dam is considered to be in this category. Normally the flow will be passed through the dam directly, but there are provisions to store for later release. The extent to which water may be stored depends on the available air space in Beardmore Dam. Following an extended dry period a volume of 30-35,000 ML is required to be released at the correct rate to ensure a flow through the major watercourses to replenish stock and domestic supplies.
Supplemented water allocation	An entitlement to water from major infrastructure (i.e. Beardmore Dam) that is owned and operated by a Water Supply Provider.
Unsupplemented water allocation	An entitlement to take water from higher level river flows (i.e. in excess of supplemented water allocation requirements) that is managed by the resource manager (DNRM).
Overland flow water licences	These are licences that exist to harvest water directly from the floodplain (in floodplain dams).

Callandoon and Yambocully Water Supply Schemes

The Yambocully and Callandoon Creeks run within the Queensland area of the Border Rivers Catchment which lies across the Queensland and NSW border. A significant part of the state boundary is located along major rivers in the Border Rivers Catchment, such as the Dumaresq, Macintyre and Barwon Rivers.

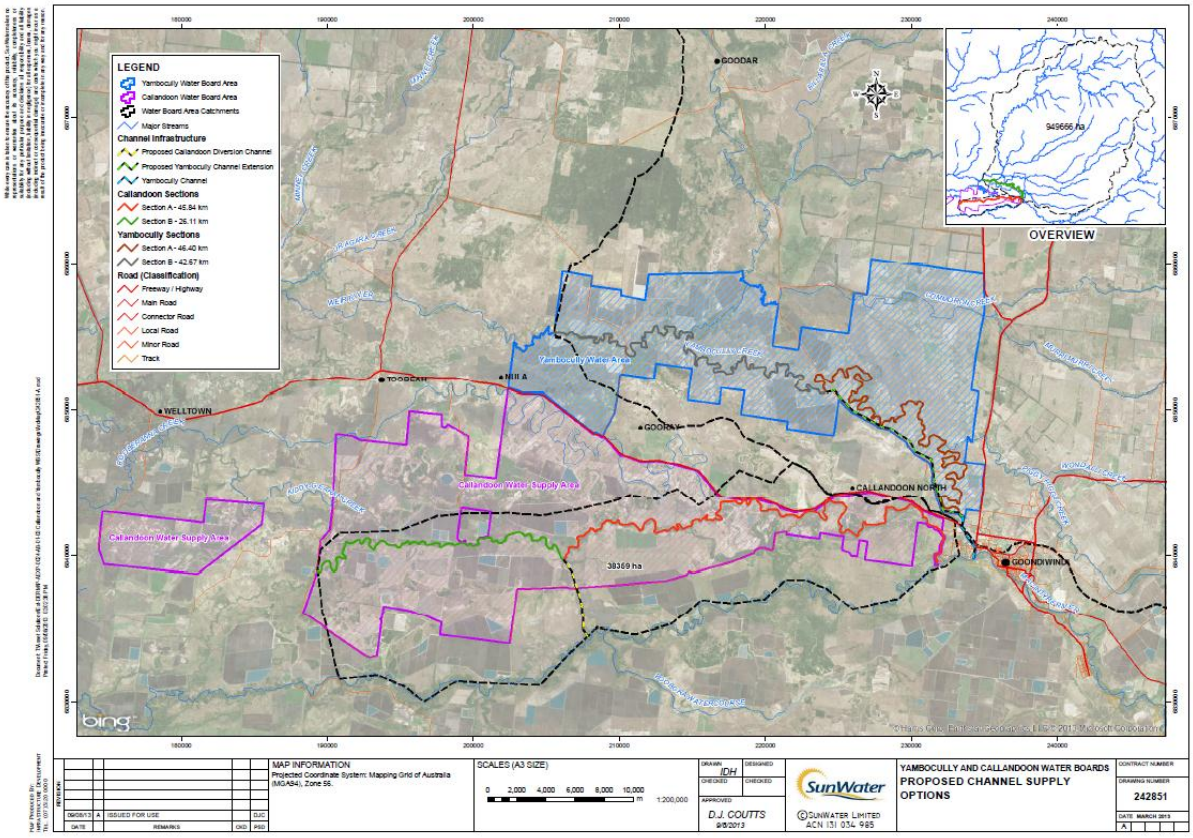


Figure 1. Location of Yambocully and Callandoon water supply schemes

The Callandoon and Yambocully Water Boards are statutory bodies under the *Water Act 2000*. Each of the boards has been issued with a distribution operations licence to authorise water distribution infrastructure and to divert water from the Macintyre River for the benefit of their members.

The Water Boards provide rural landholders with water to support stock and domestic and irrigated cropping enterprises. Both schemes provide a mix of supplemented and unsupplemented allocations from the Border Rivers Water Supply Scheme. Generally, most irrigators within these schemes also have access to water harvesting and overland flow diversions and use on farm storages to manage their water supplies. Supplemented annual allocations however are relatively small and accessibility is low (average availability of 45%) while unsupplemented annual allocations are more significant and typically have higher announced allocations.

The Callandoon Water Board uses a 50 kilometre section of Callandoon Creek for the distribution of supplemented water (4,500 ML of nominal volume) and unsupplemented water (8,800 ML of nominal volume).

The Yambocully Water Board uses a 45 kilometre section of Piggy Piggy, Crooked & Yambocully Creeks and Weir River for the distribution of supplemented water (5,800 ML of nominal volume) and unsupplemented water (7,600 ML of nominal volume).

Within these two supply schemes it appears that most losses are generated from the need to refill water holes after a dry period, although there are some known sandy sections in Callandoon Creek. Options that target opportunities to reduce the length of natural watercourses used in the distribution system would be the most effective for water savings. To this end, six options were identified for the Yambocully and

Callandoon water supply schemes which include a combination of channel, partial pipe and full pipe for each scheme.

Our initial investigation indicated that the investment in pipelines will be a high cost alternative and there is a real potential to over-capitalise in capacity. We found that piping for high flow deliveries is considered a costly and impractical option. Piping for supplemented allocations could achieve irrigator benefits but not significant water savings, as the losses associated with delivering unsupplemented allocations will still be incurred.

Our review of the options also included an initial assessment of environmental considerations and we found the Basin Plan process had not identified any significant environmental assets in the creeks that require particular water targets. The ecological character of the creeks is actually relatively unknown.

Through discussion on economic, social and environmental considerations it was decided in conjunction with the Project Steering Committee to progress the conceptual design of a channel option for each system. It should be noted that the analysis was based on the best data available and used the coarse NASA surface data for topography.

Based on the savings in length of watercourse eliminated from the distribution systems, the preliminary estimate of water savings that might be generated from the two channel options would be 1,600 ML from the Callandoon system and 400 ML from the Yambocully system. The savings would be across both supplemented and unsupplemented water, as losses in the system are proportional to scheme share of these water types.

The capacity of the channels in the design was based on the existing diversion and pump stations capacities which included; 500 ML/d (5.8 m^3/s) for Yambocully and 1,000 ML/d for Callandoon. However in the Callandoon system one existing user had established an independent pump station and, as such, capacity for this allocation would not be required. Based on the reduction in unsupplemented allocation, the required capacity is to be approximately 860 ML/d (10 m^3/s) for the Callandoon system.

Through our analysis we found the optimal components for the channel supply options to provide both supplemented and unsupplemented allocations (with the former piggy-backed on the latter as per the current delivery method) include:

Table 2. Optimal components for the Callandoon and Yambocully channel supply options.

Callandoon channel supply options	Yambocully channel supply options
6 m channel bed width	6 m channel bed width
1800 DIA rising main	Inclusion of 13 bridge deck crossings
Pump duty of 10 m3/s at 5 m lift	Piped siphons at 6,250m and 9,300m
Pump configuration of 3 x Batescrew 32-60-16 axial flow pumps	Piped outlet and Goodar Road Crossing at end

A Benefit Cost Analysis (BCA) was conducted for the channel works for the Callandoon and Yambocully systems, the key findings of which are presented below. For the water supply schemes this analysis was conducted for three alternative uses of water saved:

- *Water for environmental flows* (the Commonwealth receives all benefits and covers all costs)
- *Water used to increase irrigation* (irrigators receive all benefits and cover all costs).
- *Shared benefits and costs* (all capital, ongoing costs and 75% of benefits allocated to the Commonwealth, whilst no costs and the remaining 25% of benefits allocated to irrigators).

This work also included sensitivity analysis for key inputs and parameters to determine if and how different input values and assumptions would materially change the outcome of the analysis. The outcomes of the BCA are shown in the table below. Red text shows where the economic measure indicates that the project is not economically viable.

Table 3. Results of benefit cost analysis.

Economic measure	Pessimistic[1]	Most likely	Optimistic
Callandoon			
Water used for environmental flows			
Net present value	-$4,980,000	-$1,790,000	$1,860,000
Benefit cost ratio	0.28	0.72	1.33
Water used to increase irrigation			
Net present value	-$4,720,000	-$3,040,000	-$1,370,000
Benefit cost ratio	0.32	0.52	0.76
Shared benefits and costs – the Commonwealth perspective			
Net present value	-$5,470,000	-$2,920,000	-$20,000
Benefit cost ratio	0.21	0.54	1.00
Shared benefits and costs – irrigators perspective			
Net present value	$560,000	$820,000	$1,080,000
Benefit cost ratio	N/A	N/A	N/A
Yambocully			
Water used for environmental flows			
Net present value	-$7,180,000	-$5,850,000	-$4,390,000
Benefit cost ratio	0.06	0.16	0.30
Water used to increase irrigation			
Net present value	-$6,130,000	-$5,260,000	-$4,390,000
Benefit cost ratio	0.20	0.25	0.3
Shared benefits and costs – the Commonwealth perspective			
Net present value	-$7,310,000	-$6,130,000	-$4,870,000
Benefit cost ratio	0.05	0.12	0.23
Shared benefits and costs – irrigators perspective			
Net present value	$390,000	$430,000	$470,000
Benefit cost ratio	N/A	N/A	N/A

Callandoon

Under the channel parameters in the concept design, the BCA indicates that where the water is used to increase environmental flows, the project may be viable under an optimistic set of assumptions. The project's viability is particularly susceptible to the actual savings achieved and the economic value placed on additional water provided to the environment. Given the location of the project and the fact any environmental flows delivered are of a lower-order priority for the Commonwealth, it is less likely this project would present value for money as a source of increased environmental flows.

The BCA also indicates that the project is not economically viable for increased irrigation production as the costs exceed the benefits. In addition where the benefits and costs are shared, the project is not viable for the

[1] Based on observed willingness to pay for water for environmental flows from the Restoring the Balance tender and the Healthy Headwaters programmes. Pessimistic value based on lowest average tender sales. Optimistic value based on top end of prices paid under Healthy Headwaters project. Most likely value is the average of the two extremes in values.

Commonwealth. Where the benefits and costs are shared, the project is viable for irrigators. However, that is simply due to the fact that 25% of the savings benefit irrigators while all of the costs are covered by the Commonwealth.

Yambocully

Under the channel parameters in the concept design, the BCA indicates that the project is not viable under any circumstances, irrespective of whether water savings are used to enhance environmental flows or increase irrigation production. Under all circumstances costs exceed any benefits.

The exception to this is where benefits and costs are shared between the Commonwealth and irrigators. Under this scenario, the project is not viable for the Commonwealth, but beneficial to irrigators. Again, that is simply due to the fact that 25% of the savings benefit irrigators while all of the costs are covered by the Commonwealth.

Cost effectiveness analysis and benchmarking

A Cost-effectiveness analysis (CEA) was also used to compare options for this project. Firstly, a benchmarking exercise was undertaken to compare the lifecycle cost of securing a ML of water. This is particularly useful for comparing options to return water to the environment. Secondly, the levelised cost was calculated (essentially the average $/ML/annum). This is particularly useful when comparing the savings achieved to other supply options.

Results of the benchmarking exercise indicate the following:

- **Callandoon.** The benchmarked costs are higher than prices paid under the Restoring the Balance water tender, but generally in line with other infrastructure-based savings measures. The project may have some limited appeal to the Commonwealth as a means of securing environmental flows. However, this would be highly dependent on the relevant site-specific ecological benefits that could be derived from the use of the water or the delivery of water to other locations further afield. The levelised cost of achieving water savings $224-334/ML/annum is a relatively costly means of securing water and is unlikely to be of any real interest to investors in water supply augmentation and /or savings projects given the dominant crops in the region and the limited reliability of the water supply.
- **Yambocully.** This project would be an extremely high cost means of securing water for environment flows. It is highly unlikely that the Commonwealth would have any interest in investing in this project as a way of enhancing environmental flows. The levelised cost of achieving water savings $990-1,479/ML/annum is significantly higher than the current cost per ML of water supplied by the Boards ($34.20/ML/annum based on Board's reported costs and water delivered in 2011-12).

Consistent with the BCA, the application of different types of CEA indicate that the Callandoon project justifies further detailed analysis, while the Yambocully project should not proceed beyond the current level of analysis.

Currently the supplemented water for these systems needs to be provided on the back of an unsupplemented flow to mitigate the very large transmission losses. The project however may have more success if viewed only from better management of supplemented water and the value that landholders would put on having improved assurance of its delivery, including when they want it. In such a scenario the infrastructure costs would be downsized and so would the cost of the scheme.

There may be scope for direct negotiation between the Commonwealth and the Scheme Boards to cover the cost of construction of the pipe asset in return for being gifted the equivalent value in unsupplemented allocation. This option has not been considered in any detail as part of this report.

Conclusion

Our conclusion is that the original concept of constructing a channel to provide unsupplemented and supplemented allocations, whilst feasible as a potential efficiency measure under the SDL adjustment mechanism, does not provide a sufficient economic argument to proceed. The work has however identified some other options that may be feasible and warrant further communication with the irrigators in these two areas.

Upgrade of outlet works on Bifurcation Weirs in the Lower Balonne

The Lower Balonne catchment area is part of the Condamine-Balonne Catchment which covers approximately 14% of the Murray Darling Basin and has a 1.6 million hectare floodplain situated at the downstream end of the catchment. Approximately 30% of the Lower Balonne River Floodplain System is in Queensland and 70% is in New South Wales.

As with many Australian river systems, flow and flood events are highly variable. The median annual flow at St George is 1,300 GL and as low as zero flow during droughts. Flow events usually occur in summer and autumn and are generally small and stay within channel. Frequency of flood events can range from five years without a flow to several flows in a single year.

The natural system is ephemeral, but is now subject to regulation from releases through Beardmore Dam, upstream of St George. Regulated releases provide for environmental purposes, stock and domestic water supply and irrigation diversions.

The Lower Balonne River system is a braided series of waterways that are distributed across the floodplain to the south of St George in Queensland. The waterways split from the Balonne River channel and mostly re-combine downstream in NSW, in the Barwon River. Downstream of the town of St George the Balonne feeds a braided network of channels, waterholes and floodplains of the Narran, Bokhara/Birrie, Ballandool and Culgoa rivers, and Briarie Creek. During flood events these channels carry a significant proportion of the areas overland flow.

Principal environmental assets currently recognised by stakeholders in the system are the instream habitats and floodplain wetlands of the Culgoa floodplain and the Narran Lakes. The latter are essentially terminal lakes at the end of the Narran River and are a Ramsar listed wetland. Murray Darling Basin Authority (MDBA) studies based on limited data have determined ecological targets and flow indicators for those assets (MDBA 2012 and 2012a). Other environment assets for which targets and indicators have not been determined by MDBA are streams and floodplain wetlands in the distributary streams between the Culgoa and Narran Rivers.

Until environmental water requirements for these assets are better understood, water management options in this study are assessed within the context of the Queensland Water Resource (Condamine and Balonne) Plan 2004 (WRP), the Condamine and Balonne Resource Operations Plan 2008 (ROP) and ecological targets and flow indicators developed by the Murray Darling Basin Authority when determining the Ecologically Sustainable Level of Take for the Basin Plan (MDBA 2012, MDBA 2012a).

The WRP sets out outcomes, including ecological outcomes, for the plan area. Water is to be allocated and managed in a way that seeks to achieve a balance in those outcomes. The ROP contains event management rules (environmental management and water sharing rules) for managing low flows, managing medium flows and managing Narran Lakes filling flow events.

The ecological targets and flow indicators developed by MDBA for the Lower Balonne River Floodplain are to be measured at the Brenda gauge on the Culgoa River. The ecological targets and flow indicators developed by MDBA for Narran Lakes are to be measured at the Wilby Wilby gauge on the Narran River.

There have already been Commonwealth Government water entitlement purchases in the Lower Balonne system. At this stage, the purchased water is left in the river to help return the system closer to a pre-development condition.

The bifurcation weirs have been designed to redistribute flows up to about 1,500 ML/d (as measured at St George), but are particularly designed for the Environmental Stock and Domestic (ESD) flow of 730 ML/d from Beardmore Dam so that this is equitably distributed among the four distributary streams on the basis of stream length. The weirs are in pairs and are located a short distance downstream of the bifurcation points in the waterway. They are fixed crest sheet pile structures with shallow rectangular slots. At medium flow rates (>1,500 ML/d at Jack Taylor Weir in St George) the weirs overtop and they quickly drown out as flows increase, meaning they only have influence during the low flow releases. The actual flow redistribution proportions vary for different flow rates.

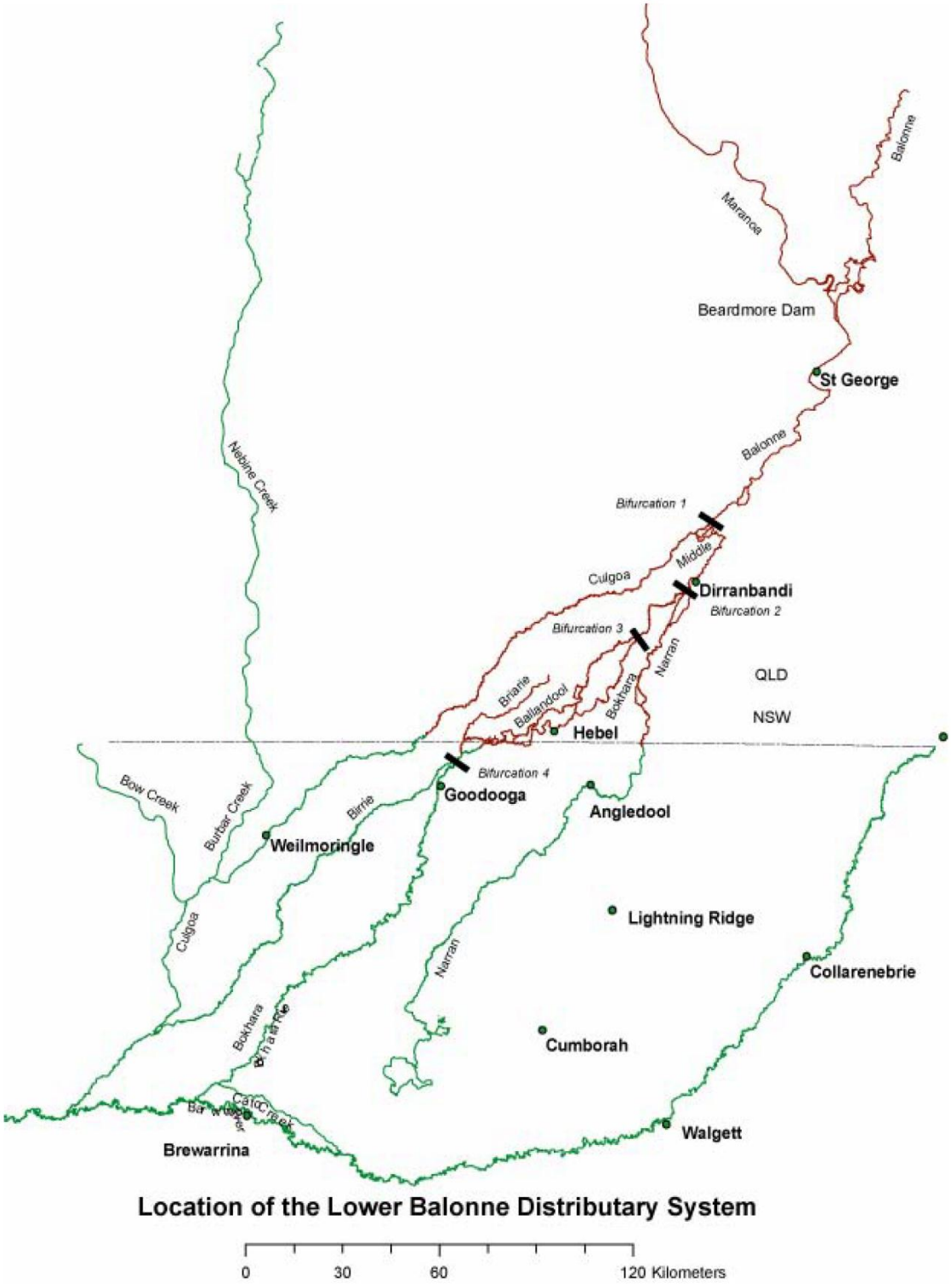


Figure 2. Lower Balonne distributary system and location of bifurcation weirs (from NRW 2007).

We identified three options to better manage flows in the Lower Balonne including; providing regulation gates at Bifurcation Weirs 1 and 2; providing regulators on all 4 bifurcation weir pairs; and raising all the weirs so that larger flows (i.e. low to medium flows) can be regulated were all aligned with the project scope. We also identified a fourth option which considered the use of offstream storages downstream of St George.

Through discussion on economic, social and environmental considerations it was decided in conjunction with the Project Steering Committee to progress the conceptual design of providing regulation gates at Bifurcation Weirs 1 and 2, as well as building a narrative around the potential use of offstream storages.

With the adoption of such an outcome (Options 1 and 4) it was proposed that the system would have the potential to deliver water allocated for environmental purposes to offstream storages on the Narran River. This could then be released from the storages to be added to, or follow on from, flow events in the Narran to enhance environmental outcomes downstream in the Narran Lakes. In this way the water can be delivered to the Narran Lakes at flow rates that minimise losses. The flexibility of this system would also allow operators to direct flows into the Culgoa, Balonne Minor, or Narran systems separately to replenish refugia waterholes during drought periods if required.

The adjustment to Bifurcation Weirs 1 and 2 involve installing a gate into the slot in the exiting weirs so that one or other of the waterways can receive flows preferentially. Given in stream debris is a key consideration it was proposed to use lay flat gates and options of both air bellow and hydraulic ram actuation were considered acceptable.

The hydrology model for the Lower Balonne is built in the Integrated Quantity and Quality Model (IQQM) and its ability to model a system that has ongoing changes to the parameters, (such as continually adjusting the weir crest height based on flow volume and duration) was beyond its capability. A decision was made to understand how effective a change in the low flow would be on the health of the Narran Lakes if there was a permanent change in the direction of the low flows. In order to simulate this the flows for the B1 weirs were adjusted to allow 10% of the low flows go down the Culgoa and 90% down the Balonne –Minor, and for the B2 weirs, 10% to go down the Balonne –Minor and 90% down the Donnegri to the Narran. Flows over the low flow (>1,500 ML/d at Jack Taylor Weir in St George) obviously follow the normal pre development flow distribution.

The results indicated an exceptionally good outcome for the Narran Lakes where the gauge at Wilby Wilby (upstream of the lakes) saw the flows in the low flow segment almost returned to pre development conditions.

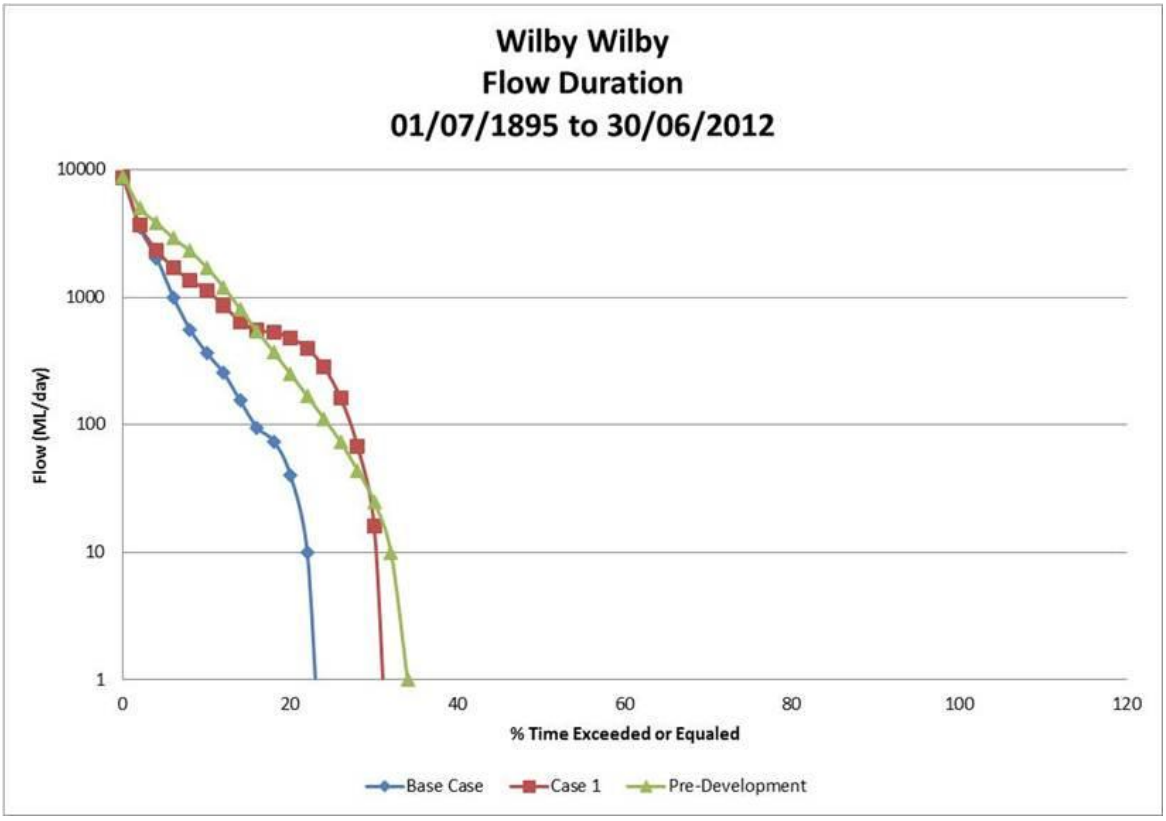


Image 1: **Figure 3**. *Gauge data for Wilby Wilby.*

However, given there is no additional water in the system the impact on the western side of the system (Culgoa) drove the system further from the pre development case.

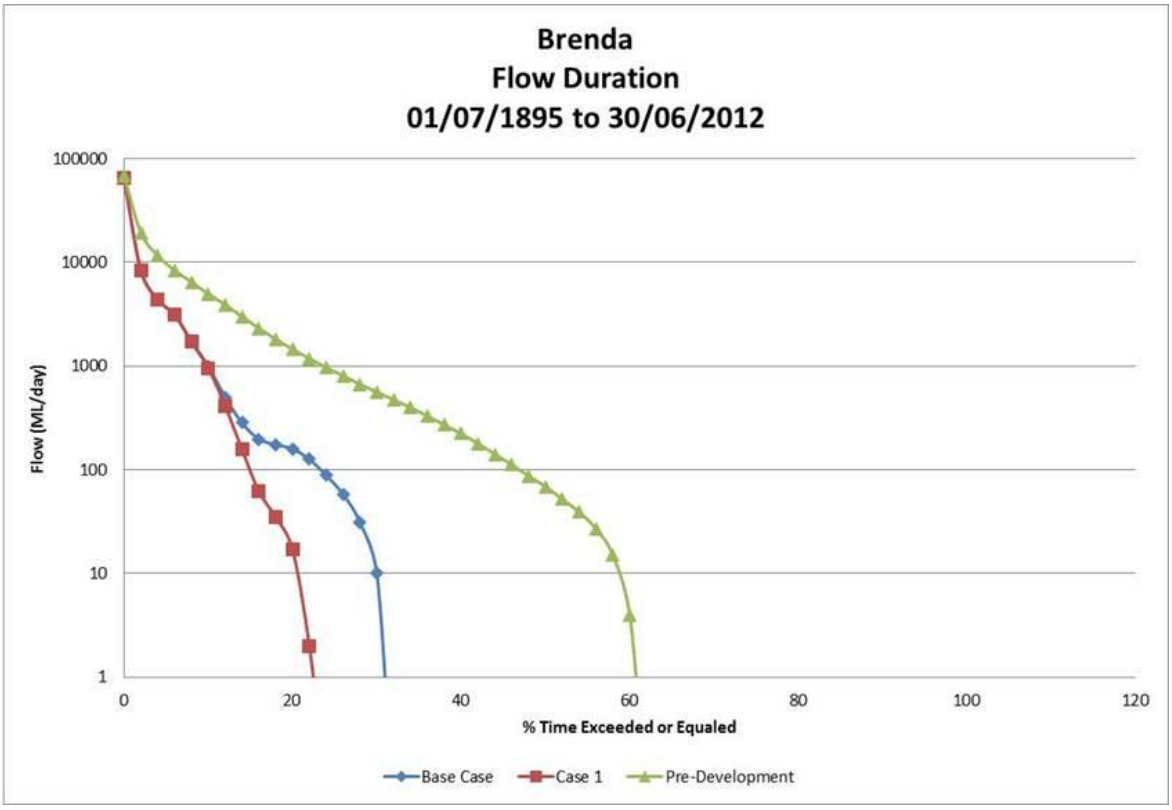


Image 2: **Figure 4.** *Gauge data for Brenda.*

The modelling outcomes are useful to understand the extent of the benefit that could be provided to the Narran Lakes, but it does not adequately reflect the proposed operation where the gates would be continually adjusted based on previous and anticipated flow events, and only for limited lengths of time.

The relative value of this concept design therefore comes down to the perceived environmental gain in the Narran Lakes as opposed to the perceived environmental loss in the Culgoa system. The environmental assets and ecosystem services that were considered of primary importance for the Lower Balonne system included:

- Narran River system: the Narran Lakes terminal wetlands system (including Narran Lakes Ramsar site – wetlands of international importance)
- Culgoa River system: Lower Balonne Floodplain wetlands and distributaries – (includes the largest number of wetlands in any part of the Murray-Darling Basin)
- In-stream pools and habitat refuges for aquatic invertebrates, fish, frogs, waterbirds, etc. (particularly in the Culgoa River system where longitudinal connectivity in the Murray Darling system is important for native fish passage during migrations).

We note that for any water management options developed to be comprehensive in addressing the environmental water requirements of the Lower-Balonne system, science-based ecological targets and flow indicators also need to be established for the distributary streams located between the Culgoa and Narran Rivers. However until this is resolved, we have assessed options within the context of the existing Water Resource (Condamine and Balonne) Plan 2004 (WRP), Resource Operations Plan (ROP) and ecological targets and flow indicators developed by the Murray Darling Basin Authority (MDBA) for the Lower Balonne River Floodplain and Narran Lakes

If the Commonwealth considered meeting the ecological needs in the Narran Lakes were a higher priority than those of the Culgoa river system, then the proposed concept is a functional and cheap way to achieve this outcome.

However, with further consideration of the use of offstream storages, there is the opportunity to add substantial value to the regulation of the bifurcation weirs. In a general flow event, the water quickly rises above the river banks, spilling onto the floodplain and it is understood that only a small proportion of the water flowing into the Narran System will reach Narran Lakes (meaning that only a small portion of the water purchased by the Commonwealth is actually delivered to the Narran Lakes).

When releases are made for Environmental, Stock & Domestic purposes, it takes in excess of 6,000 ML of total release from St George to get the water to Bifurcation Weir 2. It is estimated another 30,000 ML of water is required to be released to complete the flow through the whole system. There have been occasions in the past when it is time to release stored ESD water before the summer, that the available volume has only been 6,000 ML or less. Although the whole river system required replenishment, the limited water didn't even reach Dirranbandi.

It is understood that only 14% of the daily rate of water released from St George in an ESD event passes the Narran River Gauging Station 422206A (QLD) at the Dirranbandi – Hebel Road. Therefore only 4,200 ML of the 36,000 ML released from St George passes down the Narran/Donnegri system.

The Narran River water harvesting entitlements purchased by the Commonwealth could in this case be used to fill existing offstream storages. Towards the end of an event, the harvested water could be released back into the river to ensure efficient delivery to the Narran Lakes to assist meeting ecological requirements.

Our initial understanding of the system is that there are already storage systems with spare capacity because of the current buy back of water and that there are a number of additional landholders who would be willing to sell water and make their storages available. Ideally the storages would be below Bifurcation Weir 2 on the Balonne Minor system and upstream of the refuge assets on the Culgoa system. An initial discussion with landholders as part of the consultation process indicated there is likely to be around 56GL of capacity on the Narran River (downstream of Weir 2) and 90GL on the Bokhara and Culgoa system. These storages are largely gravity fed and discharged so there would be few ongoing pumping costs.

It is proposed that the use of offstream storages could have a dramatic impact on the efficiency of water delivered to the Narran Lakes. If the Commonwealth operated an offstream storage facility on the Narran River that it filled using a portion of its purchased water entitlements, then it could have stored water available to release into the Narran River at the critical times.

Benefit costs analysis results

A BCA was conducted for Option 1 (Bifurcation Weirs 1 and 2). In the case of this BCA, costs are based on the estimated capital, operating and renewals annuity costs associated with the weirs.

A comparison with the results of a buyback option suggests that the improvement in the MDBA flow indicators for Narran Lakes (MDBA 2012a) from modification of the weirs would be better than buying back 29,055 ML of allocation along the Balonne-Minor and Narran-Donnegri streams. This analysis also included sensitivity analysis for key inputs and parameters to determine if and how different input values and assumptions would materially change the outcome of the analysis.

Assuming the estimates of substitutability are correct (i.e. modifying the weirs is a substitute for 29,055 ML of water purchases), the net benefits of the weir modifications are very significant. Even where a low benefit is estimated for the water of $608/ML, the potential benefits are worth approximately $18 million dollars.

Even though the substitutability of the weirs for buyback is not well understood, the threshold analysis indicates the lifecycle cost of the weirs is roughly equivalent to the cost of purchasing between 800 and 1,260ML on the open market (depending on cost assumptions used).

Table 4. Results of benefit cost analysis – modification of bifurcation weirs and impacts on Narran Lakes.

Economic measure	Pessimistic	Most likely	Optimistic
Net present value	$16,000,000	$18,100,000	$20,000,000
Benefit cost ratio	20	31	38
Threshold (minimum savings in water purchases required to justify weirs	1,260	890	800

The initial analysis indicates that there is significant economic benefit from modifying the weirs and the project should proceed. Clearly the benefit cost ratio for the modification of the weirs is a superior option to buybacks.

Cost effectiveness analysis and benchmarking

In terms of getting environmental flow to key assets, the modification of the weirs can be seen as a substitute for purchasing more water allocations for environmental flows.

An economic benchmarking exercise was undertaken to compare the lifecycle cost of securing a ML of water from the weirs. This was done under the assumption that modifying the weirs is a substitute for the purchase of 29,055 ML of water in the Lower Balonne. This is particularly useful for comparing options to return water to the environment. Results of the analysis are shown in the table below. Results of the benchmarking exercise indicate that modifying the bifurcation weirs is economically a very attractive option to improve environmental flows. They are significantly more cost effective than other options currently on the table and should be assessed in more detail.

Image 3: **Table 5. Results of benefit cost analysis.**

Benchmarking - $/ML	Pessimistic[2]	Most likely	Optimistic
Bifurcation weirs	$29	$21	$19
Restoring the Balance tender ($/ML)[3]	$1,795	$1,532	$1,432
Healthy Headwaters ($/ML)[4]	$4,500	$3,500	$2,500
On-farm water use efficiency ($/ML)[5]	$5,148	$4,298	$3,448

Regarding the offstream storages, a hypothetical example where an off stream storage was purchased and operated that had an effective 20,000ML capacity was explored. If the purchase price was $20 million, the pump assets had a replacement cost of $1 million and a 30 year life, and pumping operating cost were $15/ML, the lifecycle cost per ML would be $1,200/ML. This compares favourably with the cost of recent water purchases via the Restoring the Balance Tender.

Conclusion

We therefore propose that whilst the bifurcation weir modification option essentially takes water from one system to deliver more to another, there is still the potential for water savings. Proceeding with a combination of modification to the weirs and offstream storage use could substantially increase the efficiency of delivering the water currently owned by the Commonwealth to key ecological assets. The extent of the water savings is not able to be specified at this stage and requires further investigation.

[2] **Most likely outcome.** This is the outcome based on the actual engineering and scientific assessments and the average economic estimates drawn from previous studies, modelling etc. **Optimistic outcome.** This is the outcome based on an optimistic assessment of potential benefits and costs. Estimates of benefits used are 10% higher than the average used in the most likely outcome, while costs are 10% lower. **Pessimistic outcome.** This is the outcome based on a pessimistic assessment of potential benefits and costs. Estimates of benefits used are 10% lower than the average used in the most likely outcome, while costs are 10% higher.

[3] http://www.nrm.qld.gov.au/water/trading/pdf/trading_reports/water-report-supp-feb-2013.pdf

http://www.nrm.qld.gov.au/water/trading/pdf/trading_reports/water-report-unsupp-feb-2013.pdf

[4] Based in indicative costs to Australian Government for water secured for environmental flows through the Healthy Headwaters program.

[5] Source: National Centre for Engineering in Agriculture and FSA Consulting (2010) An Appraisal to Identify and Detail Technology for Improving Water Use Efficiency in Irrigation in the Queensland Murray Darling Basin

The modelled outcomes are useful to understand the extent of the benefit that could be provided to the Narran Lakes if a permanent change to the operation of the weirs was made, but it does not adequately reflect the proposed operation where the gates would be continually adjusted based on previous and anticipated flow events, and only for limited lengths of time

It is proposed that this combination approach is potentially a smart and efficient way to manage the Lower Balonne system and will more efficiently deliver the environmental water already purchased.

Further Work

If the Commonwealth wishes to progress this combination of options on the Lower Balonne system there are a number of tasks that would need to be undertaken to better understand the value proposition.

- The IQQM modelling is restrictive and an approach is required that can be more flexible in accommodating rules associated with changes to the flow characteristics of Bifurcation Weirs 1 and 2, along with the ability to model the extraction and return of water from offstream storages.
- Essentially a model is required that can be used to optimise the system. The modelling would need to be fine enough to represent the ability to extract, store and release water on the tail of higher flows (or as per other key ecological measures). The release would be designed to provide the most appropriate flow regime to shepherd the water to the assets and meet volume, frequency and duration targets. The model would optimise the storages along with manipulation of Bifurcation Weirs 1 and 2.
- We think it would be valuable for the Commonwealth to engage with landholders who own offstream storages to canvass their views on selling water to the Commonwealth and utilising effectively redundant systems in key locations. With a clearer understanding of the opportunity the modelling can be further optimised.
- There is scope to develop an operational plan of manipulating the weir flows to provide both a better ecological outcome for the Narran Lakes and no detrimental impacts to any other part of the system. The ecological assessment needs to be much more detailed to integrate with the modelling. In particular the refuge areas of the Culgoa need to be better understood in the context of fewer low flows. The current Northern Basin Workplan being implemented by the MDBA will be reviewing the science on which the Ecological Sustainable Level of Take for the Basin Plan was based. This should include an assessment of whether the existing ecological targets and flow indicators are suitable. Any findings can be incorporated into future ecological assessments.
- In addition it would be recommended that further work investigate additional options for location and design of fish passage structures on weirs in the Lower-Balonne system. These will include assessment of fish passage needs at instream structures beyond those considered in this study.

Appendix 5 – Fishway options report – executive summary - DPI

Executive Summary

Barriers to migration have been identified as a major contributor to the decline of native fish species within the Murray Darling Basin. Recognition within the Murray-Darling Basin Authority's (MDBA's) Native Fish Strategy of their impacts on river health and their listing as a key threatening process in state and Commonwealth threatened species legislation is evidence of their impact on aquatic biodiversity.

To this end, the MDBA have made significant investment in improving fish passage along the Murray River and associated anabranches through the Lake Hume to the Sea program and the Living Murray Initiative. These investments have attracted international recognition for their strategic approach to riverine restoration and their implementation of world-leading technology.

Despite the improvements along the Murray River, this investment has not been matched in the Northern Murray-Darling Basin. At present, the movement of fish within and between river systems north of Menindee Lakes remains significantly restricted by dams and weirs without adequate fish passage.

The Northern Murray-Darling Basin also represents a different ecosystem, with semi-arid and arid rivers, and a fish assemblage that is unique to the region. With the increasing knowledge of the fish ecology in these rivers and the progression of research on fishways in the last five years, an opportunity now exists to strategically address the barriers in this region, with innovative fishway designs that are more cost-effective and more water efficient, with the same or increased functionality.

This project identified 12 of the highest priority sites for improved fish passage in the northern Basin and developed both concept designs and costings for remediation of five of these. Spanning river systems in both NSW and Queensland, the project has provided a clear direction for strategic investment in fish passage infrastructure to deliver substantial improvements in river health.

Fishway concepts were specifically designed to suit the fish assemblage and semi-arid ecology of the northern Basin and considered constructability, materials, regional context, maintenance and ownership. From these designs cost estimates were developed, with contingencies, to enable the financial and practical scope of a significant infrastructure project to be assessed.

The project identified that there are two feasible approaches to rehabilitating fish passage in the northern Basin:

Strategy 1)	**Provide fish passage at the top 11 priority structures to reinstate 2,086 km of river channel.** **The total cost is estimated at $14.56 million.**

The program would address priority barriers in the Darling, Dumaresq, Condamine and Warrego rivers (Figure 1). This would greatly improve conditions for native fish by targeting sites adjacent to existing fishways to get multiple benefits, or by reconnecting long reaches of high quality habitat.

Strategy 2)	**Provide a strategic, holistic, program re-establishing broad-scale river connectivity of over 3,242 km.** **The total cost is estimated to be approximately $70 million.**

In this program we have selected the Darling River and the three key tributaries, all of which have high quality habitat; within these rivers there are 42 mainstem structures requiring

remediation (Figure 1). All of these weirs, except eight, are below 4.5 m in height. The remaining eight structures are 5.8 m to 12.1 m high and require fish locks or fish lifts. Providing fishways at the eight high-level structures is estimated to cost $32.5 million, which is an estimate derived from other recent projects; the remaining 34 structures are estimated to cost $32.3 million, which is an extrapolation from the costs generated in the present study. These estimates provide an indication of the scope of a broader project. If the broader project was considered viable, a more detailed estimate based on concept designs, as per the present project, would be essential.

Monitoring of the performance of these structures is important to optimise each design and ensure that the investment is resulting in real changes in the fish community; this is likely to add $5 million over time to the project.

Hence, the total cost of the Northern Basin Fish Passage Program is approximately $70 million. This is a comparable cost to the Hume to Sea program but 42 barriers would be addressed rather than 15, and over 3,242 km of river would be opened up to fish movements.

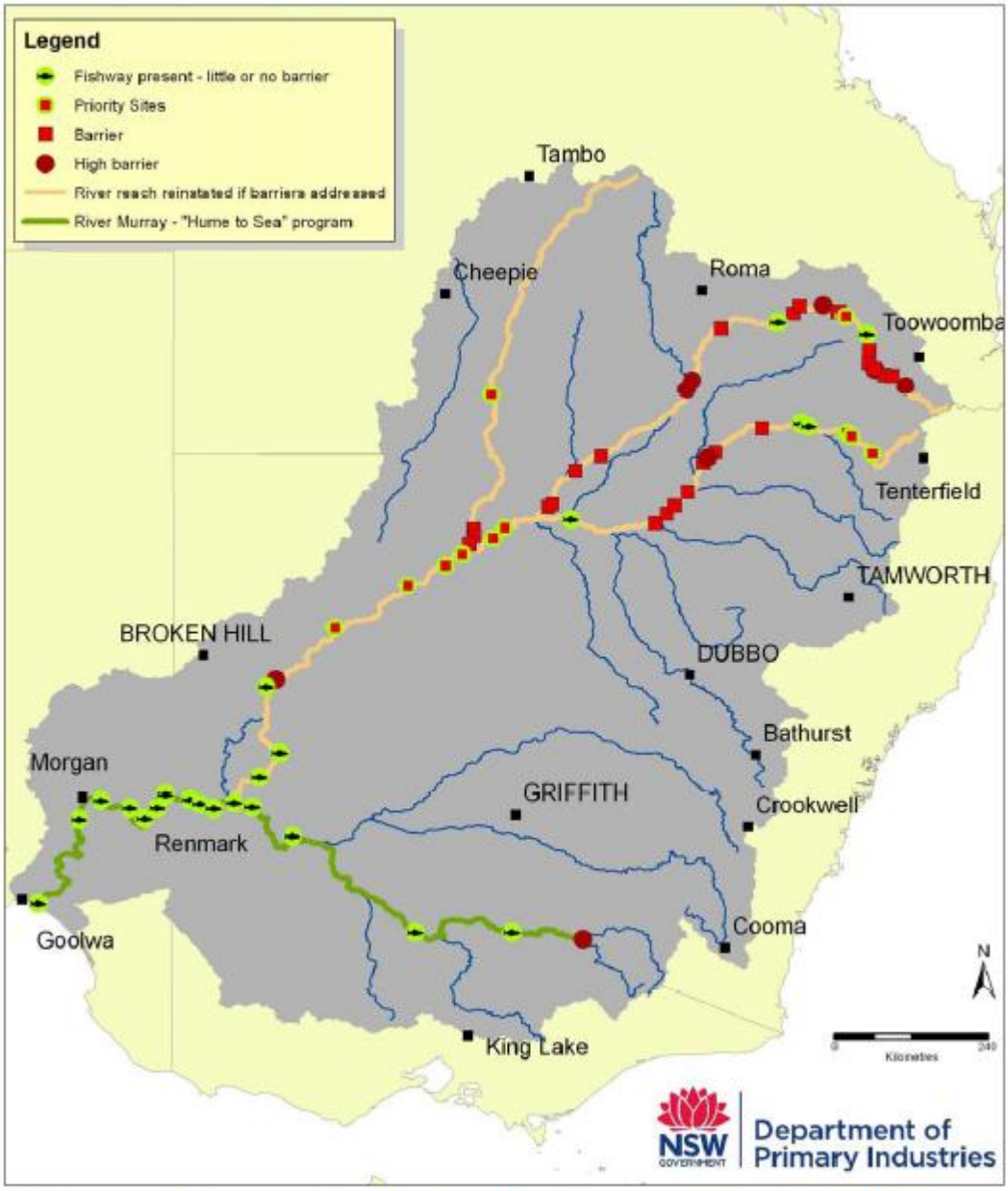
The broad-scale strategic approach is feasible largely because the main stem barriers of the rivers are not numerous and most are low-level weirs between 1.5 m and 4.5 m high. Most of these sites also do not have the high dewatering costs of the 'Hume to the Sea' program.

Like the 'Hume to the Sea' program this approach is aimed at ecosystem rehabilitation. In this case it is an arid river ecosystem and it has not previously received significant investment in rehabilitation.

The reinstatement of fish passage in the mainstem Darling and major tributaries would provide immense benefit to fish communities throughout the catchment and make a major contribution to ecosystem restoration. At a broader level it integrates:

- **Natural heritage**,
- **Cultural heritage**, as native fish are an important part of aboriginal culture, especially in arid rivers.
- **Sustainable agriculture and water resource management**, because essential infrastructure for water delivery and harvest is retained, whilst the most significant ecological impact of these structures is addressed.

Figure 1 Priority structures identified in the Northern Murray-Darling Basin and benefits associated with remediation



Note: Some listed barriers include old ineffective fishways. Boggabilla Weir is shown with a fishway, however this is ineffective for passing small fish and has been included in the total remediation costs as part of a Northern Basin Fish Passage Program (Strategy 2).

Caveat – Estimated Project Costs

Costings and designs presented in this report should be reviewed before progressing to construction stage of any site.

Detailed cost estimates of the preferred fish passage option at each priority site have been prepared here by subcontractors SMEC. A breakdown of these estimates is provided in Appendix 1 of their report (Appendix 2 of this report).

The cost estimate for each site contained a value for contingencies of 30% and all costs were based on the designs specified and December 2010 pricing.

Any modifications to the designs presented, or a delay in implementation may impact on the costs of construction due to increases in the costs of raw materials, labour, transport etc.

Cost estimates for the alternative option, where provided, were based on a standardised table of rates for materials and estimated quantities. As such these estimates should be viewed as 'ballpark' figures and are provided for comparative purposes only.

In addition, any ongoing costs, such as maintenance and cleaning of the structures are not included as these will be dependant on the final design (e.g. if trash racks are included or not).

This report estimated the cost of construction for priority sites to be between $0.356 million and $0.424 million per vertical metre structure height. In addition, Bourke Weir was estimated to cost $0.6 million per vertical metre and Cunnamulla Weir $0.9 million per vertical metre due to its remoteness. Sites where fish locks were recommended had an estimated cost of $4.5 million per fish lock.

Recent examples of remote fishway construction costs

Recent trends have seen significant increases in construction CPI (consumer price index) over and above general levels of inflation, leading to a rapid increase in costs where onground works were delayed for any period of time. This environment is likely to continue into the future.

The per metre cost of construction is a factor of the fishway's functionality; whether it is required to pass part or all of the fish community and whether fish passage will be provided under all flow conditions or only part of the hydrograph. Ultimately these issues will need to be considered by the funding body.

Since cost estimates were provided for this report two weirs on the lower Darling River in NSW (Burtundy Weir and Weir 32) have had fishways constructed. As these weirs are in remote locations, the cost of their construction can be used as a guide for the likely costs of weirs in the northern Basin. At these sites the cost per vertical metre varied from $0.46 million at Burtundy Weir to $0.78 million at Weir 32 (Mallen-Cooper, M., *pers. comm.*, 27/07/12).

Therefore, given the following assumptions:

- the estimated cost of construction per vertical metre for Bourke and Cunnamulla Weirs remains as stated ($0.6 million and $0.9 million per vertical metre respectively)
- the estimated cost for fish locks was increased to $5 million (an increase of $500,000 per site)
- the cost of construction of all other priority sites is based on costs incurred at Burtundy ($0.46 million per vertical metre) and Weir 32 ($0.78 million per vertical metre).

The total cost of construction for Strategy 1 may range from $18.51 million to $28.26 million and Strategy 2 from $72.74 million to $95.86 million using current cost estimates.

It is again reiterated that prior to progressing with construction at any site, structure designs will need to be finalised, with costings based on these new designs and current material, labour and transport costs.

Appendix 6 – Pre-feasibility report for Glenlyon Dam Multi-Level offtake - executive summary - SunWater

REPORT
GLENLYON DAM
PRE-FEASIBILITY STUDY INTO MODIFICATION OF OFFTAKE TOWER

SunWater
MAKING WATER WORK

EXECUTIVE SUMMARY

In May 2012, the Murray Darling Basin Authority (MDBA) released a Proposed Basin Plan – A Revised Draft (MDBA 2012). The aim of this Plan is to establish an efficient and balanced water management system in the Murray Darling Basin for the local communities and industries while benefiting the ecosystems. To achieve this, the plan will introduce a spectrum of initiatives, among which reductions in the existing Sustainable Diversion Limits (SDLs) will be utilised and gauged, based on a catchment and basin scale to restrict the water consumption for human activities.

To lessen the influence of the proposed SDLs strategies on those impacted areas in the Border River Basin, the Department of Natural Resources and Mines (DNRM) launched the Queensland Murray – Darling Basin Environmental works and Measures Feasibility Program in the same year. The program involved initial consultation with stakeholders to develop a comprehensive list of environmental works and measures. During the process, the potential for thermal pollution from the water releases from Glenlyon Dam was identified. It is understood that the current arrangement of the offtake tower only allows water to be drawn from lower levels of the storage, which potentially exerts adverse impacts on the downstream fish species.

ID was subsequently requested by Infrastructure Management, on behalf of the Department of Natural Resources and Mines (DNRM), to undertake a pre-feasibility study into the modification of the existing offtake to a multi-level tower.

Several options were considered and weighed using SunWater's experience with operating each option. The recommended solution is to install removable bulkhead gates using the existing infrastructure on site. It is estimated that this would cost in the order of $2,365,000 to $2,663,600.

Queensland Government